This Book is Due on the Latest Date Stamped

THE UNIVERSITY OF TEXAS
PUBLICATION NUMBER 6304
February 15, 1963

Upper Cretaceous Ammonites from the Gulf Coast of the United States

KEITH YOUNG

BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS, AUSTIN
PETER T. FLAWN, *Director*

The University publishes bulletins twice a month, so numbered that the first two digits of the number show the year of issue and the last two the position in the yearly series. (For example, No. 6301 is the first publication of the year 1963). These bulletins comprise the official publications of the University, publications on humanistic and scientific subjects, and bulletins issued from time to time by various divisions of the University. The following bureaus and divisions distribute publications issued by them; communications concerning publications in these fields should be addressed to The University of Texas, Austin, Texas, care of the bureau or division issuing the publication: Bureau of Business Research, Bureau of Economic Geology, Bureau of Engineering Research, Bureau of Industrial Chemistry, Bureau of Public School Service, and Division of Extension. Communications concerning all other publications of the University should be addressed to University Publications, The University of Texas, Austin.

Additional copies of this publication may be secured from the Bureau of Economic Geology, The University of Texas, Austin 12, Texas

THE UNIVERSITY OF TEXAS
PUBLICATION NUMBER 6304
February 15, 1963

Upper Cretaceous Ammonites from the Gulf Coast of the United States

KEITH YOUNG

BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS, AUSTIN
PETER T. FLAWN, *Director*

The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

—SAM HOUSTON

Cultivated mind is the guardian genius of Democracy, and while guided and controlled by virtue, the noblest attribute of man. It is the only dictator that freemen acknowledge, and the only security which freemen desire.—MIRABEAU B. LAMAR

PUBLISHED BY THE UNIVERSITY TWICE A MONTH. ENTERED AS SECOND-CLASS MATTER ON MARCH 12, 1913, AT THE POST OFFICE AT AUSTIN, TEXAS, UNDER THE ACT OF AUGUST 24, 1912

Contents

Illustrations

Tables

Upper Cretaceous Ammonites from the Gulf Coast of the United States

KEITH YOUNG

ABSTRACT

THE AMMONOIDEA of the Austin chalk have not heretofore been studied. Although their preservation is not as good as would be desired, 82 species of ammonites are recognized and described, of which 42 species receive new names; they are distributed through 35 genera. About half of the species are Collignoniceratidae. The most abundant groups of ammonites are the texanitines, submortonicerines, and menabitines. A few important species from older and younger strata are described, including 13 from the Upper Campanian and 1 from the Upper Turonian.

Reginaites is thought to be a lowest Campanian descendant of *Texanites.* Three morphological clines of *Submortoniceras* can be defined, and the superposition indicates that at least one of these may represent a lineage.

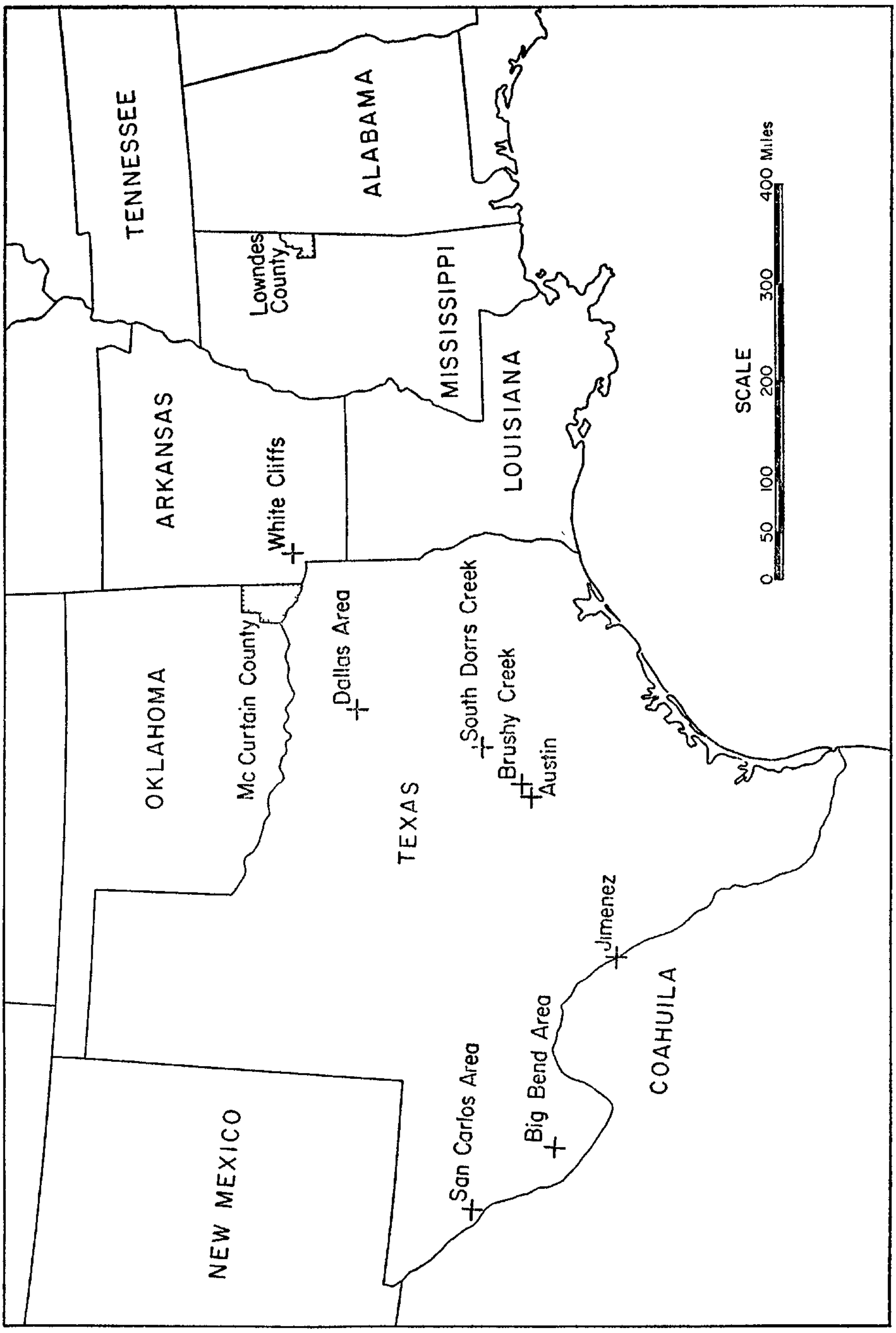
Combined with a re-evaluation of important pelecypod species, the results of the ammonite studies indicate the following: The upper Austin chalk of the type area and the Burditt marl are roughly equivalent in age to the Brownstown-Gober and Brownstown-Ozan sequences of northeast Texas and adjacent Arkansas, which in turn are roughly equivalent to the Eutaw-Mooreville sequence in Mississippi, and are also approximately equivalent to the Telegraph Creek–Eagle sequence of the northern part of the Western Interior.

The zones applicable to the eastern Gulf Coast appear to be the same as those applicable to Texas. The zones of the Rocky Mountain region and the Great Plains are entirely different from those of equivalent strata in Texas, within the Senonian, and correlation can be estimated only by the mutual occurrence of unusual fossils. The zones of the standard European sequence cannot be set up in Texas with any great accuracy. Instead, a parallel zonation must be set up in each area, and a correlation estimated on rarely occurring fossils, stage of evolution, homotaxial superposition of family and generic groups, and intuition.

INTRODUCTION

The Austin chalk is one of the more prominent units of the inner Gulf Coastal Plain (text fig. 1). It is surprising, with so many publications concerning this formation, that so little is known of its paleontology. Stephenson has studied the oysters, but even Cushman (1946) and Frizzell (1954), when listing and illustrating the Upper Cretaceous Foraminifera, lump everything together from the Austin chalk as if there were only one horizon. Frizzell lists many species from the Austin group, but most of the collecting in Central Texas has been from the upper part of the Austin chalk, and the Foraminifera of the Austin chalk of the type locality, particularly in its lower part, have not received proper detailed attention in the literature. Most of the fossil evidence for dating the Austin chalk has come from pelecypods.

Except for a few rare works (Römer, 1852; Hyatt, 1903; Lasswitz, 1904; Scott and Moore, 1928; Renz, 1936), each of which included only a few Austin chalk species, the ammonites have likewise been largely ignored. Adkins (1933) had seen most of the ammonites, as indicated by identifications like "*Parapuzosia* aff. *stobaei,*" "*Mortoniceras* aff. *emschere,*" "*Parapuzosia* aff. *corbarica,*" "a new ammonite genus closest related to *Mortoniceras*" (=*Australiella* Collignon), "*Peroniceras*



Text fig. 1.—The Gulf Coast area.

aff. *czörnigi*," "*P.* aff. *westphalicum*," "*Gauthiericeras* aff. *margae*" (Adkins, 1933, p. 453). Presumably all of these specimens are in the Bureau of Economic Geology or the Adkins collections, but it is no longer possible, for example, to determine exactly to which of three species from the Austin chalk Adkins was referring with his identification of *Parapuzosia* aff. *stobaei*, except that he indicates this species is from the Lower Austin; and that *P.* aff. *corbarica* is from the Middle Austin. He had the holotype of *Australiella austinense*, n. sp., in mind when he wrote "and a new genus closest related to *Mortoniceras*" (i.e. *Texanites*).

In the following pages 82 species of ammonites and 9 species of pelecypods are described. Of the 82 species of ammonoids, 42 receive new names. This seems like a high percentage, but it must be remembered that the Senonian ammonites of the Gulf Coast and of Texas have never been studied. Forty-six of the 82 ammonite species are Collignoniceratidae, 14 are heteromorphs, one gaudrycerid, and 21 distributed among *Munericeras*, *Parapuzosia*, and various pachydiscine genera.

In addition to the 42 new names, 24 species have already been named; 10 species, because of poor preservation, are compared to already described species; one is related to a known species; and 5 are unidentifiable specifically. Of the 9 pelecypod species, eight are already described and one is new.

Of the 82 ammonoid species, 67 are from the limestone facies of the Austin chalk or Terlingua formation. Fifty-seven species are from rocks actually ascribed to Austin chalk by earlier authors.

The texanitines and scaphitines indicate that the Burditt marl, Gober chalk, "Upper Austin chalk" of Adkins (1933), the Brownstown marl, the Ozan formation, and others, should be placed in the Lower Campanian. Of course this depends on the assumption that a good *Submortoniceras* fauna and *Scaphites hippocrepis* s. l. are Lower Campanian.

In earlier literature the "upper Austin" and the "middle Austin" were confused, and presumably this is the reason that the *Inoceramus undulatoplicatus* zone is referred to as "middle Austin" at one locality and as "upper Austin" in another locality. Actually the *Inoceramus undulatoplicatus* zone is confined to the "middle Austin," which is lithologically similar to the "upper Austin," and in fault contact with it on Walnut Creek where Stephenson (1937) studied these units. *Inoceramus undulatoplicatus* is confined to that part of the Austin chalk which is Lower Santonian, the upper part of formation B of the present work.

Acknowledgments

In a work such as this, one is indebted to so many that all acknowledgements are not possible. I am in some way indebted to anyone who has ever donated an Austin chalk ammonite to a collection. The late Dr. J. T. Lonsdale gave me free access to the collections of the Bureau of Economic Geology. Dr. Peter Rodda of the Bureau of Economic Geology and Mr. J. T. Twining, formerly with the Bureau, have always been most co-operative. Mrs. W. S. Adkins has been most helpful in allowing me to consult the Adkins collections.

Encouragement of various individuals has always been an inspiration. Among these I owe a particular debt to R. T. Hazzard and H. B. Stenzel.

The stratigraphic studies of many graduate students, including Edward Marks, James E. Gordon, A. E. Hartwig, W. F. Roux, and others, have helped to form the lithostratigraphic grid to which the biostratigraphy is tied. Fossils have been collected and given to me or to various of the collections by R. T. Hazzard, Oscar Paulson, Frank Welder, T. B. Henderson, and others too numerous to mention. Austin chalk ammonites are not abundant, and if it were not for collectors such as these no empirical data could be established. S. P. Ellison, my administrative superior, has at various times helped me to find the time to do this work.

R. K. DeFord and many of his graduate students, particularly Jesse Brundrett, Wayne Miller, Philip Braithwaite, and Ralph Duchin, have added to the collections from Trans-Pecos Texas. Gardley Moon's (1953) collection from the Agua Fria Quadrangle, Brewster County, Texas, was invaluable, and inspired Adkins and Twining to further collect in this area.

It was through association with Prof. F. L. Whitney that I first became convinced that the Austin chalk problems were not insoluble, and J. L. Patton's (1932) thesis at The University of Texas further demonstrated the utility of fossils within the Austin chalk.

Drs. G. A. Cooper and Preston E. Cloud kindly permitted me to compare Gulf Coast collections in the United States National Museum. The late Dr. J. B. Reeside, Jr., was kind and co-operative, as always. Drs. Norman Sohl and Ralph Imlay were no less so.

Dr. E. C. Colbert allowed me access to the Whitfield fossils at the American Museum of Natural History. This afforded the opportunity to clear up particular problems concerning *Submortoniceras vanuxemi* (Morton).

Miss Constance Wollman has allowed me access to her collection, which contains, among other fossils, the only two specimens of *Eulophoceras* from the Austin chalk. During the summer of 1959 Vernon L. Ryan aided with the photography.

To all of those with whom I have argued—to whom I have queried—and from whom I have stolen—bits of stratigraphic information here and there; and to all of those who have contributed a *Texanites* from Comal County, a *Peroniceras* from Uvalde County, or some similar contribution; and who are not mentioned by name herein I humbly apologize and express my gratitude.

The publication of the many plates of fossils herein was made possible by a grant to the Geology Foundation of The University of Texas from Mr. George Coates, San Antonio, Texas. A travel grant from the University of Texas Research Institute afforded me the opportunity to visit the U. S. National Museum and the American Museum of Natural History. Research grants from the Geology Foundation, The University of Texas, gave me time to complete much of the detailed work.

STRATIGRAPHY

When I first started to study the ammonites of the Austin chalk, I did not know that there were nearly so many forms. Unfortunately, the ammonites seem to have run in "schools"; at least they were buried in "schools." One may collect Austin chalk for days and find only a few scraps; then suddenly a locality will be reached where there will be a good many ammonites. One of the more prolific areas, and this would be considered poor collecting by anyone who has collected some of the mediocre European or South American areas, has been the basal Dessau limestone on Brushy Creek, Williamson County (text fig. 2). Only four species, from four genera, have been collected at this locality. Frequently it has been difficult to find enough specimens of different genera together to work out what species belong to the same substage. *Prionocycloceras gabrielense*, n. sp., has not been found in association with any other ammonite. It occurs above the *Peroniceras*-bearing beds and below *Texanites stangeri densicostus* (Spath). *Protexanites planatus* (Lasswitz) has not been found in association with other ammonites, but it likewise occurs above *Peroniceras*-bearing beds and below *Texanites stangeri densicostus*. With no more information than this *Protexanites planatus* and *Prionocycloceras gabrielense* are assumed to represent the same zone because of the superposition relationships. In all the total number of Coniacian ammonites is small, and the Coniacian is far from satisfactorily zoned.

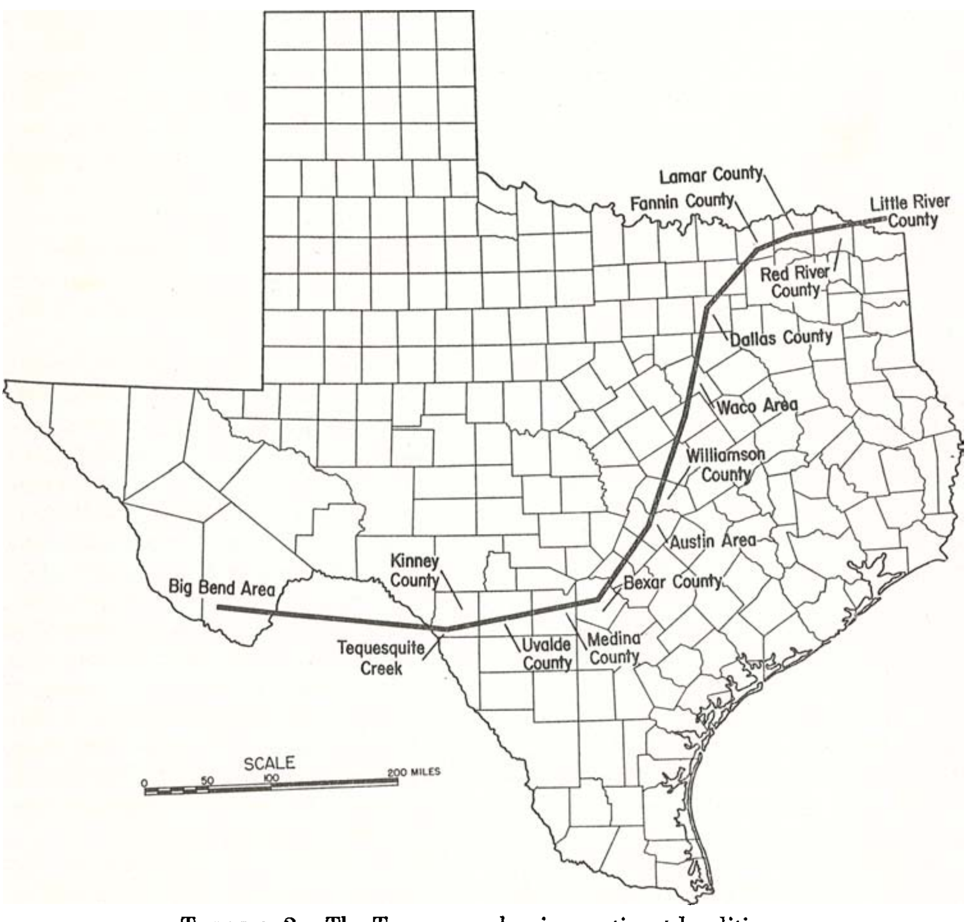
The principle of zonation that has been used for the Austin chalk is that of assemblage zones of ammonites, but most assemblages are small. The assemblage zones have been dated, first by superposition to obtain their relative ages. Most of the zones have been found in superposed relationship sufficiently often to accept them empirically. However, a few zones, such as the zone of *Prionocycloceras hazzardi*, n. sp., in Trans-Pecos Texas, have not been tied in by superposition. It contains no species from classical sections, and its age is inferred. This is extremely unsatisfactory, but is the best that can be done at this time. The zone of *Prionocycloceras adkinsae*, n. sp., is also not tied in by superposition.

Haas (1958) has recently complained that I (1957) did not state the size of my hypodigms for my taxa. His complaint is probably valid for several species if he considers the hypodigm as including all of the sample of the new species studied by the author. I have interpreted Simpson (1940), as has Newell (1949, p. 139), that "every specimen definitely referred (in publication) to a species is or has been part of its hypodigm." In other words the hypodigm does not include those individuals of a species not definitely referred to in print, or by illustration, or mensuration. In Newell's interpretation of the hypodigm, then, its size is automatically given, because it includes only those individuals assigned to the species in publication, usually only a small part of the sample.

In the present work some estimate of the size of the sample is given. However, with some taxa, I am not able (or not willing) to draw a sharp boundary between the definite members and the doubtful or "cfr." members. Stating a definite sized sample assumes that one is able to classify all fossils into the various categories, and this I am most certainly not enough of a catastrophist to do. Thus I am not willing to state the size of the hypodigm unless, by following Newell, which apparently Haas (1958) does not do, I restrict the hypodigm to those individuals that have been definitely referred to the species (in publication); in other words the published sample.

When one is discussing how many individuals of a particular species of fossil are known, should one count all of the fragments, and if not, what size fragment is to be the limiting size? Many individuals are identifiable only after one has become familiar with a taxon by studying well-preserved individuals; such individuals are not fit subjects for taxonomy, but are important stratigraphically. Should these be listed and counted? If definitely referred to as a species (and published) they automatically become part of the hypodigm. There are other fossils more or less intermediate between taxa. I do not deem it necessary to propose new taxa for these, and I will not be bound to including them in existing taxa, even though I realize that taxa must eventually have mutual and mutually exclusive boundaries. For the present, as far as I am concerned, they are neither one nor the other, but are intermediate. I am certainly not yet capable of setting up a continuum of taxa, and consequently see no reason to worry about the intermediate forms, unless they become important biostratigraphic markers, or important in working out lineages.

The hypodigm then would seem to vary with what writers consider fit to describe and/or study, and, even more likely, it would seem to be at the mercy of the amount of detail or the number of illustrations a publishing medium is willing to publish, if Newell is followed by including in the hypodigm only those forms which have been definitely referred to a taxon in the literature. If this concept is followed, then the hypodigm may have no numerical relation to the sample unless the sample is one specimen only.



TEXT FIG. 2.—The Texas area showing pertinent localities.

The hypodigm is not as readily adapted to stratigraphic work as is the typological concept. From a paleobiological viewpoint it is perfectly logical, but perhaps inconvenient, to have the type as a name bearer, and it matters not whether it is typical of the taxon which bears its name.

However, stratigraphy is also a science of probability, in which there is no room for odd-balls (atypical individuals) because there is too great a chance that the atypical individual does not actually represent the taxon concerned, but is typical of some other taxon. This can readily be seen from the work of Trueman and Wier (1946). One of their "aff." forms, or even "cfr." forms could well be the atypical holotype of a taxon. Further study and collecting might prove, as it did with some of Trueman and Wier's groups, that these atypical things really represented different species, and the former taxon for which it had been the holotype then needed a new name and a new holotype.

That any atypical specimen belongs to a certain taxon is a subjective pronouncement which if not ignored should be eyed critically by the biostratigrapher. Such human hazards of species interpretation should not be added to the difficulties already inherent in biostratigraphy. The working biostratigrapher, when working with any taxon, always ignores the atypical individuals. He probably even ignores the individuals intermediate between the typical and atypical. In other words there is a certain part of any group that the biostratigrapher uses. This part may be that represented by one standard deviation, two standard deviations, or more, but he probably never uses as many individuals as would be represented by three standard deviations. I do not believe that the actual part of a sample used by the biostratigrapher has ever been computed, but the atypical ones have to be ignored. Thus, if the holotype of a species is atypical, that species either becomes useless or nameless as a communicable biostratigraphic tool, especially if extremely small samples only are available.

One problem of splitting then comes up when the stratigraphic use for certain fossils arises. Fossils can be stratigraphic tools at a taxonomic level sufficiently detailed to discourage the conservative with the number of new taxa that could thus be proposed, and, though Jeletzky (1955a) disagrees, it seems to me that stratigraphy sometimes calls for the naming of an evolutionary "dead-end." Jeletzky (1955a) has also referred to the top-heavy taxonomy of ammonites at the specific and generic levels. However, it doesn't seem to be much worse than the modern cephalopods (Robson, 1929), and in my opinion the ammonites do not seem to be fragmented taxonomically any more than the Graptolithina, the Foraminifera, the Rugosa, the Brachiopoda, or several other groups.

I certainly do not see how Jeletzky (1955a) with his plexi can hope to date as accurately as Cobban (1958) with his horizontal classification, no matter how much I personally prefer the Jeletzky type of classification. For world-wide geochronological work Jeletzky's methods may be the best; for local and regional work Cobban's is superior. Whatever our classification we have to satisfy the needs of both types of correlation, the geochronological, and the biostratigraphical.

In spite of the loud cry against further splitting the specialists keep on describing new taxa. I can talk strongly on this subject because I have probably been as loud as any in my outcry against the fragmentation of Foraminifera, Rugosa, and Brachiopoda, but seldom the Ammonoidea. Except for a few specialists who profess and practice non-splitting, both non-specialists and specialists seem to be in the vulnerable position of maintaining that the man who knows least about the taxonomic structure of a group is the recognized leading specialist for the group. No matter how good the arguments, the basis for the arguments seems unsure, because the recognized specialist is the one being criticized.

Let us assume an impossibility for the sake of argument—that a particular sample varies quantitatively in two different directions; it is impossible because undoubtedly it varies in many directions. If at two different localities, the parts of the hypodigm from those localities vary equally in both directions, then a good correlation might be made. If the variation in both directions is greater in that part of the sample from one locality than it is from the other locality, the correlation might be good from the locality with less variation to some part of the locality with greater variation, and only questionable in the other direction. Now, if that part of the sample from one locality varies most in one direction, and that part from the other locality varies most in the other direction, there may be no valid correlation, since the variation could possibly, but not probably, result from chronologically simultaneous different reactions of gene complexes to environment (e.g., a good correlation), or it could most probably result from non-synchronous reactions of gene complexes to environment (e.g., a poor correlation). Biostratigraphers cannot safely assume a low probability of non-synchronous gene reactions to environment, unless there is morphologic identity. Immediately someone will raise the question of homeomorphy, but I am concerned here with generic and subgeneric categories in which homeomorphy, if present, would be almost impossible to validate.

Consequently the biostratigrapher finds it necessary to correlate only the morphologically like (or similar), including like ontogenies, parts of the sample and/or hypodigm, and to ignore the end members; whereas the paleozoologist, studying evolution with only small samples, may be as interested in end members as in the typical members of the sample or hypodigm.

Adkins (1933), Renz (1936), and the writer (Young and Marks, 1952) have identified *Parapuzosia corbarica* (Grossouvre) from the Gulf Coast of Texas and adjacent Mexico. Paleozoologically the identification seems to be sound because one can easily say that these different specimens all fall within the range of variability of most ammonite species, and this is what the above authors implied. But, as we shall see, the identification falls down on a stratigraphic analysis. The individuals described by Renz belong to the *P. corbarica* hypodigm, until removed. Their position in the hypodigm is by definition because they were there described, and has nothing to do with their relation to Grossouvre's individuals, except as this relationship existed in the minds of Renz, Adkins, and myself. Furthermore, Renz's individuals are just as easily removed from the hypodigm, and they actually are the juveniles of *P. bösei* Scott and Moore (1928).

In examining the figures of Renz (1936, pl. 4, figs. 1, 1a, 2, 2a) it will be seen that the Texas forms have the major or primary ribs differentiated and extending continuously across the venter, whereas in the forms figured by Grossouvre (1894, pl. 27, figs. 1a, 1b) the primary ribs on the venter are not differentiated from the secondary. It is not out of reason for any species to have as much variation as the total variation illustrated by the individuals of Renz and Grossouvre combined, except perhaps, to a specialist very familiar with the species of *Parapuzosia.* The difference between the European forms and the American forms is consistent, but the samples from Europe (published and illustrated) and from Texas and Mexico are too small to be significant. Because they were so small, the two samples should have received different names originally, merely because they differed. Furthermore, *Parapuzosia corbarica* Renz (1936), Adkins (1933, *pro parte*), and Young and Marks (1952) [not Grossouvre, 1894] is the juvenile of that tremendous form called *Parapuzosia bösei* by Scott and Moore (1928).

I must further point out that the correlation of the upper part of the Austin group with the Santonian of Europe was based largely on the identification (actually misidentification) of *Parapuzosia corbarica* in Texas. The associated fauna shows the Texas form (*P. bösei* Scott and Moore) to be well up in the Lower Campanian, considerably younger than the European *P.*

corbarica. Thus a small variation can be extremely important stratigraphically, and unless the samples are large enough to be significant, the biostratigrapher cannot afford to make the correlation unless the morphology is identical. The biostratigrapher cannot afford to say, *a priori,* "This is a reasonable specific variation and I will include these two forms in the same species." To him the only variable part of the hypodigm that is important is that part which consists of the topotype material. All too often in ammonites this means the only stratigraphically important part of the hypodigm is the holotype. Then, if the holotype is an odd-ball—is atypical—and there is nothing else quite like it, the entire taxon becomes useless for stratigraphic communication.

Simpson (1940) has expressed the concept of the holotype serving only the useful purpose of being a name bearer, and Spath (1923) before him, apparently was developing the same concept, but with stratigraphy in mind, when he argued for species with restricted vertical (stratigraphic) variation and great geographic variation.

The concept of the holotype, or for that matter a type species, serving only as a name-bearer is not always convenient to detailed biostratigraphy. In addition erroneous correlations have resulted from such or similar concepts in the past. The state of knowledge concerning most Upper Cretaceous ammonites is still so meager that it is impossible to differentiate geographic variation from variation in time. This is the reason that correlation by range zone (Hedberg, 1958) is unsatisfactory, at least in some groups, unless each morphic type (morphospecies) is treated as a taxon. In other words, since time and geographic variation cannot be separated, and assuming variation in time, the probability of an "exact" correlation is greater if exact morphologic identities are correlated. This results in either a greater multiplication of names, or a greater use of cf., cfr., and aff., or the use of the double standard discussed by Sylvester-Bradley (1956), Spath (1933), and Young (1960b).

I have been hard put to save a zone of *Texanites texanus* (Römer), and have not been very successful. This ammonite, which Basse (1931) called ubiquitous and the omnipresence of which Haas (1942) was already dubious, now appears to be restricted to Texas, unless, as Collignon (1948) points out, the individual discussed but unillustrated by Peron (1897) belongs to it. Not only is *Texanites texanus texanus* (Römer) restricted to Texas, but I have been able to locate only 7 individuals including the holotype. Realizing that *Texanites texanus auctorum* was a rather loosely interpreted taxon, Collignon (1948) described several subspecies including *Texanites texanus gallica* (=*Texanites texanus* Grossouvre, 1894, and presumably other European examples). Certainly no *Texanites texanus texanus* (Römer) have been illustrated from outside of Texas. As Haas (1942) points out, Römer's species is characterized by special tuberculation, costation, and especially by its sparsity of costation. Furthermore, it is known from the zone of *Inoceramus undulatoplicatus* (Römer), from which zone Römer probably obtained the holotype; this should put it in the Lower Santonian, below the top. Furthermore, all evidence indicates that *Texanites texanus gallica* occurs in formation C, immediately overlying the zone of *T. texanus texanus. T. texanus twiningi,* n. subsp., may represent the zone of *T. texanus texanus* in Trans-Pecos Texas, but it may also be younger.

T. texanus twiningi, T. texanus gallica, and other (1948) subspecies (Collignon uses varieties) may be subspecies of one species, but there is no excuse, taxonomically and nomenclatorially, for these to be subspecies of *T. texanus,* except for the exigencies of biostratigraphy—except for the very practical reason that the worldwide zone of *Texanites texanus* has already become a part of the standard sequence (Haug, 1908–11; Spath, 1926; Muller and Schenck, 1943; Gignoux, 1955; Neavorsen, 1955).

From this particular problem of *Texanites texanus* can furthermore be pointed up one of the inaccuracies of biozone or range-zone correlation. The biozone is defined by the cumulative horizons of the members of the hypodigm, or sample, which represents in some manner the variation of the species. Now, if the holotype of a species or the typical subspecies of a species falls outside of the morphologic group used for correlation as it has and still does in *Texanites texanus*, the biostratigrapher no longer has a valid name for the morphologic unit he is using. For this reason subspecies which otherwise might be separated, are here grouped together into the single species *Texanites texanus* s. l.

The zone of *Texanites texanus* was set up as the upper zone of the Lower Santonian on the basis of European material quite different from the Texas holotype, but no one knew (or knows now) what the biozone of this taxon represents in years, or in terms of other zones. The only practical out, now, is to have a zone of *Texanites texanus* s. l. and in different geographic areas the zone will be represented by different subspecies of *T. texanus*, some of which may be more restricted as subzones than is the zone. Fiege (1951) would never agree to any system so practical, but it is comparable with Arkell's (1956, p. 29) discussion of separate zonal sequences for separate provinces.

The sample of *T. texanus texanus* has now been reduced to seven individuals, and if Newell (1949) is followed and only those specimens which have been definitely assigned to the species in the literature are included in the hypodigm, the hypodigm, with the publication of this work, consists of only 4 individuals illustrated plus 3 assigned by collection number.

The Austin Chalk

The type area of the Austin chalk, a résumé.—Because it was one of the earliest formations of Texas to receive a name, the nomenclatural history of the Austin chalk has been long and varied. Römer (1852) did not name any formations, but he collected fossils from the rocks we now call Austin, and he included these in his "rocks of the lowlands." Shumard (1860, pp. 583, 585) used the name "Austin limestone." Even now "limestone" is more appropriate, as a lithic name, than is the more familiar and more used "chalk."

Although Shumard (1860) correctly placed his limestone above the Eagle Ford (=Fish bed of Shumard) in North Texas, in the Austin area he did not ascertain the true stratigraphic relations of his Austin limestone. Shumard did not recognize the fault zone later called Balcones by Hill (1889a). Believing the strata to be near horizontal Shumard thought that the Austin passed under the Comanche Peak limestone, topographically higher in the Balcones escarpment. He further included in the lower part of his Austin limestone the "bluish" clays of formations we now call Taylor and Navarro, which, because they were topographically lower, he presumed to pass under the Austin of the White Rock escarpment. We know this because in his list of Austin fossils he includes *"Gryphaea" vesicularis*, *"Nautilus" dekayi*, and *Exogyra costata*, in addition to his description of the blue clays in the base of the Austin limestone. Marcou (1862) misplaced some of the older Cretaceous formations, but correctly placed Shumard's Austin limestone at the top of the Cretaceous sequence, with, of course, the blue clays included.

Little work was done on the Austin chalk in the next 30 years. In 1880 Cope (1880, pp. 5, 6; Sellards, 1931) recognized the fault later called Balcones by Hill (1889a). The recognition of the fault paved the way for a reinterpretation of the Cretaceous stratigraphy of Central Texas.

In the late 1880's and early 1890's Hill and Taff rectified many of the earlier errors in stratigraphy, which had accumulated largely as a result of the failure to recognize the Balcones fault. In his earliest writings Hill was not particularly careful regarding priority, and in his report on the Cross Timbers Hill (1887), named the formation, which Shumard had called Austin, the Dallas limestone. In his early writings for the Texas Geological Survey (1890a)

Hill did not consistently use Austin, although Dumble (1890, pl. III) apparently did. Hill used White Rock Division and Austin-Dallas limestone most of the time, reverting to Austin limestone only once (p. 14).

Hill (1889b) had not yet recognized the fault and attributed (p. 287) the topographic higher level of the lower Cretaceous along the Balcones escarpment to pre-Upper Cretaceous folding. In this paper Hill used Austin-Dallas limestone, as he did in 1890. In a third paper in the same year (1889c) Hill recognized the Balcones fault. In all papers published in 1889 Hill applied the following terms to the unit we now call Austin: Austin-Dallas limestone, Dallas limestone, White Rock formation or division (a valid geographic name from White Rock escarpment), Rocky Comfort chalk, and Austin limestone. The first four names have long been relegated to synonymy. Not recognizing the extent of the faulting at Austin, Hill arrived at the same thickness for the formation at Austin and Dallas—about 625 feet.

J. A. Taff (1892) was the first to study the Austin chalk in detail. His Lampasas-Williamson section is close enough to the Austin area, for practical purposes, to be included in a general description of the Austin in the type area. Taff's nomenclature, with modern counterparts, is given in table 1.

Taff, in 1892, broke the Austin down to almost as much detail as is used by the specialists at the present time, and into much more detail than is used by most workers. Taff's work completes the early studies of the Austin chalk in Central Texas. Hill (1901) merely quotes details from Taff's work. Likewise Hill and Vaughan (1898; 1902) add nothing to the stratigraphy of the Austin chalk in the type area.

By 1933 Adkins had named Taff's marly lime zone the Burditt and had divided the remainder of the Austin chalk into lower, middle, and upper. Taff's classification, Adkins' classification, and the classification of this work are compared in table 1.

TABLE 1.—The classification of the Austin group of the type area after Taff (1892), Adkins (1933), and this work.

Taff, 1892		Adkins, 1933		This Work	
Chalk Marl		Lower Taylor		Lower Taylor	
	marly lime zone	Burditt			"D"
					Burditt
Austin	*aucella* horizon	Austin	upper	Austin	Dessau
	arenaceous horizon	chalk		group	"C"
			middle		"B"
	unnamed lower Austin		lower		"A"

Subsequent work has shown that upper, middle, and lower, as used at Austin, while agreeing with Taff's section, do not agree with upper, middle, and lower as used at Dallas, or as used in the Rio Grande embayment.

Young and Marks (1952) did not alter the rock nomenclature. They did apply Stephenson's (1937) zones, with some modifications, to the stratigraphy of the Austin chalk in Travis and Williamson counties. The Young and Marks' zonal system is compared with Taff's (1892) classification in table 2.

The more thorough and more up-to-date work by Clarence Durham* (1949, 1955,

* Durham's (1956, unpublished) classification

TABLE 2.—The classification of the Austin used by Taff (1892) compared to the zonation of Young and Marks (1952).

Taff, 1892		Young and Marks, 1952
Chalk marl		Lower Taylor clay
Austin ls.	marly lime zone	*Ostrea travisana* zone
		Ostrea centerensis zone
	aucella horizon	*Exogyra laeviuscula* zone
		Gryphaea aucella zone
	arenaceous horizon	*Texanites internodosus* zone
	unnamed lower Austin	*Inoceramus undulatoplicatus* zone
		Inoceramus subquadratus zone

1956) has resulted in an excellent but unpublished rock classification. Until the publication of this classification I am using the terminology in the right hand column of table 1, where it is compared with the classification of Taff (1892) and Adkins (1933). In all of its details it applies only to Williamson and Travis Counties.

The classification on the right in table 1 is developed from work of the writer and University of Texas graduate students plus published notes by Durham (1949, 1955, 1956) and Hazzard (1955; and in Lonsdale, Maxwell, Wilson, and Hazzard, 1956). Formation D of the Austin group is the upper limestone member of Adkins' Burditt, and the Burditt is now restricted to the lower part of the original Burditt as described by Adkins (1933). Formation C is almost identical with the arenaceous horizon of Taff (1892), but the base of the Dessau is placed at an unconformity (Hazzard, 1956) and includes the upper several feet of Taff's arenaceous horizon. Formation B is the upper chalky part of Taff's unnamed lower Austin, and formation A is the lower part of Taff's unnamed lower Austin.

Because the fossils of the Austin chalk, excepting echinoderms and oysters, are usually poorly preserved steinkerns, most of the Austin fossils have never been described. Römer (1852) collected and described many fossils, including the following species from rocks we now call Austin:

Brachiopoda
- *Terebratulina guadalupae* (Römer)

Pelecypoda
- *Exogyra ponderosa* Römer
- *E. laeviuscula* Römer
- *Spondylus guadalupae* Römer
- *Pycnodonte aucella* (Römer)
- *Durania austinensis* (Römer)
- *Inoceramus undulatoplicatus* Römer
- *Liopistha elegantula* (Römer)

Echinoidea
- *Hemiaster texanus* (Römer)

Ammonoidea
- *Texanites texanus* (Römer)
- *Stantonoceras guadalupae* (Römer)
- *Baculites anceps* Römer
- *Baculites "asper"* Römer
- *Texasia dentatocarinata* (Römer)
- *"Nowakites" flaccidicostus* (Römer)

Conrad (1857) illustrated two of Römer's (1852) species, correctly identifying *Exogyra laeviuscula*, but misplacing it in the genus *Gryphaea* (1857, pl. 7, figs. 4ab). Conrad illustrated specimens of *"Gryphaea" aucella* (Römer) (Conrad, *pro parte*, 1857, pl. 21, figs. 3abc), but misidentified them as *G. pitcheri* Hall, not

was given at the XX International Geological Congress, Mexico City. His nomenclature was used by Murray (also 1961). Formations A, B, C, and D of this work are equivalent, respectively, to Durham's Atco, Vinson, Jonah, and Big House formations.

Morton. Conrad's *Exogyra foliacea* is the upper valve of Römer's *Exogyra laeviuscula.* These fossils are from Leon Springs, Bexar County, instead of Leon Springs, Pecos County.

Adkins (1929, 1931) described only two fossils from the Austin chalk, *Sauvagesia acutocosta* and *Coilopoceras austinensis.* Stephenson (1929b; 1936) concentrated largely on oysters, and described *"Gryphaea" wıatheri, Lopha travisana, "Ostrea" centerensis,* and *Exogyra tigrina* from the Austin group, and Scott and Moore (1928) described two species of giant "cart-wheel" ammonites, *Parapuzosia bösei* and *P. americana.* Lasswitz (1904), fıom the Römer collection and from fossils sent to Germany by George Stolley, an early Austin school teacher, described *"Schloenbachia" quattuornodosa, Texanites minutus, Protexanites planatus,* and *Bostrychoceras wysogorskii.* Only a few fossils are known from the lower Taylor clay, and these are not diagnostic.

The earliest attempts to zone the Austin were based on pelecypods, if microfossils are excluded, and a really satisfactory microfossil zonation is yet to be published. Stephenson (1937) early recognized that the base of the *Exogyra ponderosa* zone was down in the Austin, but he felt that its appearance was not a good index because it crossed the horizon he considered an Austin-Taylor unconfoımity. Stephenson (1937) further zoned the Austin sequence in the type area on pelecypods; this zonation is compared with other zonations in table 3. Young and Marks (1952) revised Stephenson's (1937) zonation (table 3).

Stephenson's zonation was revised for seveıal reasons: (1) *Exogyra tigrina* represents the top of the Austin in Travis County and not the base of the Burditt as Stephenson (1937) thought. The specimens of *E. tigrina* in the basal Burditt are worn and reworked from the underlying Dessau at a local erosion surface which accompanied the activity of a small Cretaceous volcano at Pilot Knob (Hill, 1890b; Romberg and Barnes, 1954; Weiss and Clabaugh, 1955; Durham, 1955). (2) Stephenson had apparently misinterpreted Römer's *"Gryphaea" aucella* for the small shells in the upper Dessau and also in the Burditt. These are merely juveniles, and Stephenson's *"Gryphaea wratheri"* is the adult

TABLE 3.—A comparison of zonations of the Austin group of Central Texas from Stephenson (1937), Adkins (1933), and Young and Marks (1952).

<table>
<tr><th>Stephenson, 1937</th><th>Adkins, 1933</th><th>Young and Marks, 1952</th></tr>
<tr><td>Ostrea travisana</td><td rowspan="2">Parapuzosia americana</td><td>Ostrea travisana</td></tr>
<tr><td>Ostrea centerensis</td><td>Ostrea centerensis</td></tr>
<tr><td>Exogyra tigrina</td><td rowspan="2">Texanites sp.</td><td>Exogyra laeviuscula</td></tr>
<tr><td rowspan="2">Gryphaea wratheri</td><td>Gryphaea aucella</td></tr>
<tr><td>Barroisiceras dentatocarinatum</td><td>Texanites internodosus</td></tr>
<tr><td rowspan="2">Inoceramus undulatoplicatus</td><td>Austinites, n. gen.</td><td rowspan="2">Inoceramus undulatoplicatus</td></tr>
<tr><td>Texanites minutus</td></tr>
<tr><td rowspan="5">none named</td><td>Gauthiericeras sp.</td><td rowspan="5">Inoceramus subquadratus</td></tr>
<tr><td>Barroisiceras dartoni</td></tr>
<tr><td>Peroniceras aff. westphalicum</td></tr>
<tr><td>Texanites quattuornodosum</td></tr>
<tr><td>Coilopoceras austinense</td></tr>
</table>

form of the fossils he considered (Stephenson, 1937) to be *"G." aucella* Römer. Young and Marks (1952) called the upper range of *"G." aucella* the *"G." aucella* zone, since it ranges even lower than Stephenson thought, occurring below the *Inoceramus undulatoplicatus* zone on the San Gabriel River, Williamson County.

A new ammonite zonation is now being proposed which replaces the Adkins' (1933) zonation and with which it is compared in table 4. The present zonation differs from the tentative zonation of Young (1960a) as shown in table 5.

In the proposed ammonite zonation there are several departures from the Ad-

TABLE 4.—A comparison of the ammonite zonation used by Adkins (1933) with the ammonite zonation presented in this work.

Formation	Adkins, 1933	This Work
Lower Taylor	*Scaphites hippocrepis*	*Delawarella sabinalensis*
"D"	*Parapuzosia americana*	*Delawarella delawarensis*
Burditt		
Dessau	*Texanites* sp.	*Submortoniceras tequesquitense*
	Barroisiceras dentatocarinatum	*Texanites shiloensis*
"C"		*Texanites texanus gallica*
"B"	*Austinites* n. gen.	*Texanites texanus texanus*
	Texanites minutum	*Texanites stangeri densicostus*
	Gauthiericeras sp.	*Prionocycloceras gabrielense*
"A"	*?Barroisiceras dartoni*	
	Peroniceras aff. *westphalicum*	*Peroniceras westphalicum*
	Coilopoceras austinense	*Peroniceras haasi*

Young and Marks' zones are probably unnecessary. Although they may always be useful for local work, it is believed that with the development of an ammonite zonation and the to-be-hoped-for planktonic foraminiferal zonation, that the pelecypod zonation will decline in importance.

Adkins (1933) gave a zonation of the Austin chalk on ammonites, but since most of the species were related to European species and were never described, the zonation was impractical. The zonation published by Young (1960a) suffers the same defects. Also, Adkins' middle Austin chalk varies in age across the outcrop in Texas, because of the confusion of Dessau type chalks with a similar chalk here called formation B. Adkins' zonation is compared to Stephenson's (1937) and Young and Marks' (1952) in table 3.

kins zonation which need explanation. The question mark preceding *Barroisiceras dartoni* is not Adkins', it is mine. I have not yet been able to verify the horizon of the species described by Reeside (1932). Adkins identified some of his fossils as related (aff. or cf.) to European forms. When described, the taxonomic changes are more apparent than real. The *nomen nudum* of Adkins, *Austinites,* n. gen., (1933, p. 407) is the species herein described as *Australiella austinensis,* n. sp. The zonation which I am proposing is based entirely on collignoniceratids, whereas Adkins (1933) interspersed unrelated forms. Also Adkins' Taylor zonations (1933, p. 407) were interspersed from a Trans-Pecos Texas section, and had not (nor have they yet) been described in superpositional sequence with the Austin zones, although Young (1958a;

1960b) has stated that there is such an occurrence. This superpositional sequence, observed since the publications of Adkins, alters the zonal sequence greatly. For instance, *Delawarella delawarensis* has been collected from formation D and *Scaphites hippocrepis* s. l. from the Dessau chalk. These two fossils occur together in the Brownstown marl (Stephenson and Reeside, 1938; Dane, 1929). Since Young (1960a) published his tentative zonation *Placenticeras guadalupae* has been recovered from the Dessau chalk, zone of *Submortoniceras tequesquitense,* and has not been recovered from Taylor rocks, or from rocks normally attributed to the Santonian.

Scaphites hippocrepis has been reported from the Taylor (Scott, 1933), but I can find no record of the locality; I suspect a locality between Bell County and Dallas, but cannot be certain. Stephenson and Reeside (1938) also report *S. hippocrepis* from the Taylor clay, but without giving a locality. Since the base of the Taylor is of different ages in different areas, it is possible for *S. hippocrepis* to be Taylor in some areas and Austin in others.

"Kreide des Hochlandes" as Senonian and his "Kreide am Fusse des Hochlandes," including rocks we now call Austin and Taylor, as Turonian. Marcou (1862) correctly placed the Austin limestone and the blue marl in the Senonian, but following Shumard, had the blue marl beneath the fish bed (Eagle Ford). Hill seldom bothered with European correlations and standard sections, but in 1894 (p. 337) he implied that the post-Benton (e.g. his Glauconitic Division) was Senonian, and in this he was correct. Lasswitz (1904) attributed all of his fossils we now know to be from the Austin to the Emscherian. Böse, by 1919, knew that the Austin and Taylor belonged to the Senonian, and of course was very definite by 1928. Likewise Stephenson by 1923 had correlated the Austin chalk as Senonian, and pointed out (p. 59) that Schlüter (1876 and 1887) had early correlated the Austin with the Emscherian or Lower Senonian. The first big dispute concerning the age of the Austin and Taylor arose when Gayle Scott (1927) stated the Austin to be of Coniacian and Santonian ages and the Taylor to be Campanian. Although his reasons

TABLE 5.—The tentative zonation of Young (1960a) compared to the more mature zonation now proposed.

Young, 1960a	This Work
Delawarella n. sp. aff. *roedereri*	*Delawarella sabinalensis*
Delawarella delawarensis	*D. delawarensis*
Submortoniceras n. sp. aff. *tenuicostulatum*	*S. tequesquitense*
Bevahites sp. aff. *bevahensis*	*Texanites shiloensis*
Texanites texanus gallica	*Texanites texanus gallica*
Texanites texanus texanus	*Texanites texanus texanus*
T. stangeri densicostus	*T. stangeri densicostus*
Peroniceras westphalicum	*Prionocycloceras gabrielense*
	Peroniceras westphalicum
Peroniceras n. sp.	*Peroniceras haasi*

The age of the typical Austin section.—Almost as soon as Cretaceous fossils were described from Texas, authors began correlating these deposits with the European section. Römer (1852) considered his may not all have been valid, as we shall see, Scott was more nearly correct than his predecessors and colleagues. Böse (1928, p. 178) criticized Scott strongly for citing *Texasia dentatocarinata* (Römer) (Scott's *Barroisiceras haberfellneri*) and *Texanites texanus* (Römer) from the same horizon, yet they do occur in adjacent strata, and contrary to Böse's suggestion *Texasia dentatocarinata* is younger than *Texanites texanus;* Scott's main error was in identifying Römer's species with *Barroisiceras haberfellneri.* Böse, on the other hand, was correct in criticising Scott for interpreting species and genera with too great latitude. For reasons to be explained later I am also inclined to disagree Coniacian for that part of the Austin chalk in which the species did not occur. Of course the Coniacian was identified in other areas by the presence of species of *Peroniceras* and *Gauthiericeras.* This is perhaps rather hard on Scott, but I have already pointed out that he was more nearly correct, concerning the age of the Taylor, than his colleagues. He interpreted his fossils, but insufficient detail was then known to be certain of the superposition of the different species.

TABLE 6.—The age of post-Turonian Cretaceous strata of Texas after Böse (1928), Scott (1927), and Stephenson (1927; 1928).

Texas formation	Böse, 1928	Scott, 1927	Stephenson, 1927, 1928
Navarro	Campanian	Maestrichtian	Maestrichtian
		Campanian	Campanian
Taylor	Upper Santonian		Santonian
Austin	Lower Santonian	Santonian	
	Coniacian	Coniacian	Coniacian

with Böse (1919, p. 13; 1928, p. 178) on the interpretation of *Exogyra ponderosa.* Römer's (1852) type of *Exogyra ponderosa* is almost certainly Böse's "Austin chalk species." Table 6 compares Böse's (1928), Scott's (1927), and Stephenson's (1927, 1928) interpretation of the European stage equivalents of post-Turonian Cretaceous strata of Texas.

Many of the interpretations are based on errors of identification. Since all three authors have borrowed from the same sources and from each other, the responsibility for such errors has become inextricably confused and extremely difficult to ferret out. The Santonian was identified on *Texanites texanus* (Römer), and every texanitid with five nodes per flank was included in Römer's species. The Coniacian was early based on *Texasia dentatocarinata* (Römer), but only Scott recorded the anomaly of this species being out of position, superposition-wise, and even Scott (1926) did not let this deter him from using the species to help identify the

Although the superposition of the sequence was confused, there was never any argument about the Coniacian age of the lower part of the Austin chalk. If the three, Scott, Böse, and Stephenson, had ever been in the field together, I suspect that there would have been no agreement on where to place the top of the lower part of the Austin chalk. Böse (1928, p. 172) stated that *Texanites texanus* (Römer) was from the base of what he called the upper Austin chalk, but this was by definition, since the Santonian part of the Austin was automatically the upper. Böse (p. 172) further indicated his belief that *T. texanus* and *T. roemeri* (Yabe and Shimizu) were the same species, but by 1930 Burckhardt (1930, p. 225), based on unpublished work by W. R. Fehr. presented a zonation definitely showing the zone of *T. roemeri* above the zone of *T. texanus.* Much of the Fehr collection is at Austin, in the collections of the Bureau of Economic Geology. The Fehr catalogue, however, has not been located. Presumably Burckhardt had seen the Fehr collection while it was still a part of the "El Aguila" collection*, because he indicates some of the identifications were his. There is a good specimen of *Texanites texanus gallica* (pl. 38, figs. 3 & 4) in the Fehr collection, and this specimen is most likely the *Texanites texanus* of Fehr in Burckhardt, since this species was called *Texanites texanus* by European authors until Collignon (1948). Nevertheless the Fehr zonation as given by Burckhardt is a considerable improvement over Böse's. Böse's (1928) and Böse and Cavins' (1928) zonations are couched in European terms and have to be taken on faith, and cannot always be used to date the formations, because the two authors did not always indicate the formation or even the lithology from which the fossils had been collected. Tatum (1931, p. 872) justifiably criticized them for omitting the local rock classification.

Burckhardt (1930, pp. 225 ff.) accepts the age dating of Böse, with the zones of *Barroisiceras, Peroniceras, Gauthiericeras,* and *Inoceramus undulatoplicatus* as Coniacian, and with the zones of *Texanites texanus, T. roemeri,* and the blue marls with *Exogyra ponderosa* as Santonian—in other words the Taylor clay as upper Santonian. Muir (1936, p. 54) also gives both the Fehr and Böse zonations as given by Burckhardt.

Although Adkins (1933) refers to Burckhardt, it is doubtful if, at the time of his writing, he had had an opportunity to study thoroughly Burckhardt's paper. Adkins' zonation, as given earlier, follows the age-dating of Böse, with the Taylor and upper Austin as Santonian. Scott (1933, p. 48) reversed himself from his 1927 position. Whether he did this by pressure of opinion of geologist colleagues cannot be determined, but whereas in his 1927 paper all of the Taylor was Campanian, in 1933 he accepted the Santonian age of the lower Taylor, approving a Campanian age for the zone of *Exogyra cancellata* Stephenson, thus including the formation we now call Neylandville in the Campanian. Scott here places *Placenticeras syrtale* and *Scaphites hippocrepis* in the Santonian. It is probable that at this time the methods of treatment of Frech (1915) and Nowak (1916) were replacing those of Grossouvre (1901) and Haug (1908–1911) as references for American writers.

Renz (1936) compounded the correlation error when he misidentified the juvenile of *Parapuzosia bösei* Scott and Moore as *P. corbarica* (Grossouvre). However, I should not criticize Renz too greatly for this, because I continued the misidentification 16 years later (Young and Marks, 1952). Why American paleontologists continued to call *Inoceramus undulatoplicatus* Römer Coniacian, after Woods's (1912, 1913) reporting of *Inoceramus undulatoplicatus* from the chalk of Haldon, and his reporting of Schlüter's variety *digitatus* from the zone of *Actinocamax quadratus* in addition to the zone of *Micraster coranguinum,* cannot easily be understood. Likewise American paleontologists continued to use *Scaphites hippocrepis* DeKay as a Santonian index (Scott, 1927; Stephenson, 1928, 1939), probably following Frech (1915) and Nowak (1916), long after it was designated Campanian in Europe (Grossouvre, 1894, 1901; Haug, 1908–1911). Jeletzky (1951) discusses this problem thoroughly, and, although Schmid (1959) argues for the Upper Santonian age of the zone of *Placenticeras bidorsatum,* most of the French workers seem to go along with Jeletzky (Basse, *et al.,* 1959; Dalbiez, 1959). Prob-

* "El Aguila" or the "Mexican Eagle" was a common designation for Compañia Mexicana de Petroleo, a subsidiary of Royal Dutch Shell. Geologists of this group later worked under the Aguila and Corona Joint Geological Department. The fossils collected by geologists from 1916 to 1932 for these organizations are included together in the W. S. Adkins collections as the "El Aguila collection." Some of these fossils were collected by W. R. Fehr and found their way into the collections of the Bureau of Economic Geology in a manner unknown to me. Other fossils collected by Fehr are with the rest of the El Aguila fossils in the W. S. Adkins collections. Burckhardt (1930) had seen the Fehr fossils and presumably most of the El Aguila collection.

TABLE 7.—Comparison of zonations proposed by Haug (1908–1911) and Grossouvre (1901) for western Europe, Collignon (1948) for Madagascar, and Jeletzky (1958) for northern Europe with the zonation herein proposed for the Texas and Gulf Coast. The spaces marked "not represented" refer to the absence of fossils only, probably as a result of different biofacies. I certainly am not enough of a catastrophist to draw on unconformity (paraconformity) at every locality I cannot find a fossil.

HAUG-GROSSOUVRE	COLLIGNON, 1948	JELETZKY, 1958	THIS WORK		
Hoplitoplacenticeras vari	Hoplitoplacenticeras vari and Canadoceras roedereri	Hoplitoplacenticeras coesfeldensis and "Hamites" phaleratus	Hoplitoplacenticeras marroti	UPPER	CAMPANIAN
Delawarella delawarensis	Delawarella subdelawarensis and Australiella australis	Pachydiscus dulmenensis Scaphites aquigranensis Scaphites hippocrepis	Delawarella sabinalensis	LOWER	
			Delawarella delawarensis		
Placenticeras bidorsatum	Bevahites quadratus and Submortoniceras rennei	Placenticeras bidorsatum and Hauericeras pseudogardeni	Submortoniceras tequesquitense		
Placenticeras syrtale	Bevahites bevahensis	Placenticeras syrtale	Texanites shiloensis	UPPER	SANTONIAN
		Placenticeras cf. guadalupae and Placenticeras clypeale	not represented		
Texanites "texanus"*	Texanites hourcqi	Texanites "texanus"*	Texanites texanus gallicus	LOWER	
not represented	not represented	?	Texanites texanus texanus		
			Texanites stangeri densicostus		
Texanites emscheris	not represented	Texanites emscheris	Prionocycloceras gabrielense	UPPER	CONIACIAN
Barroisiceras haberfellneri	Barroisiceras haberfellneri	"Texanites"* haberfellneri	Peroniceras westphalicum	LOWER	
			Peroniceras haasi		

ably some circular reasoning is involved on the part of American geologists; after mistakenly correlating certain American formations with the Santonian, if *Scaphites hippocrepis* were found in other strata, they were correlated to the American section instead of to the area where the stages were first defined.

Stephenson (1939, p. 545) correlates the Taylor with the Campanian, but later in the same paper (p. 548) reverts again to the Upper Santonian age of the lower Taylor, using *Scaphites hippocrepis* and *Delawarella delawarensis* as his Santonian indices.

Schuchert (1943) generally follows Stephenson; he inserts some of his own ideas, but follows Stephenson for the type Austin and Taylor. He will not be led into the error of using lower Taylor as a subdivision of Taylor, and calls the lower Taylor clay the unnamed marls. If one examines the excellent correlation made by Elias (1931), and then tries to correlate back to Texas, obviously something is wrong. Elias correlates the Telegraph Creek with the Campanian *Discoscaphites aquisgranensis* (Schlüter), but mistakenly has *D. aquisgranensis* older than *Scaphites hippocrepis.*

Hazzard, Sullins, and Flocks (in Lonsdale, Maxwell, Wilson, and Hazzard, 1955, table 3) give a general correlation chart, in which they show the general correlation with Europe, and in which they still include the older lower Taylor beds as Santonian.

Spath (1953) attempted to lower the base of the Maestrichtian to include the zone of *Hoplitoplacenticeras vari* (e.g. the Pecan Gap and Wolfe City sand). By including the zone of *Hoplitoplacenticeras vari* in the Maestrichtian Spath was following Grossouvre (1901) and Haug (1908–1911) who placed the zone of *Bostrychoceras polyplocum* in the Maestrichtian. In France the upper part of the zone of *Hoplitoplacenticeras vari* has been

TABLE 8.—Comparison of ranges of texanitine genera in Madagascar (from Collignon, 1948) and Texas. Dashed lines represent ranges of genera in Madagascar; solid lines represent ranges in Texas.

	GROSSOUVRE AND HAUG	COLLIGNON	Paratexanites	Texanites	Parabevahites	Bevahites	Submortoniceras	Menabites	Bererella	Australiella	Delawarella
CAMPANIAN	Hoplitoplacenticeras vari	Hoplitoplacenticeras vari and Canadoceras roedereri									
	Delawarella delawarensis	Delawarella subdelawarensis and Australiella australis									
	Placenticeras bidorsatum	Bevahites quadratus and Submortoniceras rennei									
SANTONIAN	Placenticeras "syrtale"	Bevahites bevahensis									
	Texanites texanus	Texanites hourcqui									
CONIACIAN	Parabevahites emscheris	?									
	Barroisiceras haberfellneri	B. haberfellneri									

included in the zone of *Bostrychoceras polyplocum* (Sornay, 1957b), but *Hoplitoplacenticeras vari* is sufficiently rare that perhaps its occurrences should be re-evaluated. At least no umbrage should be taken at Spath's (1953) suggestion, since he thought that he was following the classical work of Haug (1908–1911) in his classification.

Even when the zone of *Hoplitoplacenticeras vari* is included in the Campanian, the zone of *Bostrychoceras polyplocum* is included by some workers in the Maestrichtian (Basse, *et al.*, 1959; Sornay, 1957b, 1959), and Sornay (1957b) follows the Haug classification. However, Dalbiez (1959) includes the zone of *Bostrychoceras polyplocum* in the Campanian, and this classification is more likely to gain the acceptance of micropaleontologists (Reiss, 1955, p. 116). This also leaves the zone of *Exogyra cancellata* (which occurs with *B. secoense*, n. sp.) in the Campanian.

Jeletzky (1951, 1958) has given a rather thorough discussion of the European zonation. His zonation, plus the fossils which are important to the Central Texas zonation are compared with Collignon's (1948) zonation for Madagascar and the now proposed zonation for Central Texas in table 7.

There are a number of discrepancies in these correlations which need ironing out. Most of the concern is over the Campanian-Santonian boundary. Nowhere have the European workers included *Texanites stangeri densicostus* in their zonal system; the species apparently has not been found in Europe. In Texas *T. stangeri densicostus* overlies the zone of *Prionocycloceras gabrielense*, and underlies the zone of *Texanites texanus texanus*. Its exact relationship to *Paratexanites sellardsi* is not known. Consequently it cannot be determined if the zone of *T. stangeri densicostus* is equivalent to a zone of *T. texanus* in Europe, or the zone of *T. emscheris*, or is not represented. I've called the zone of *T. stangeri densicostus* Santonian and the zone of *Prionocycloceras gabrielense* Coniacian, but the absence of more typical Upper Coniacian forms of Europe, such as *P. bourgeoisi* and *Gauthiericeras margae* make more definite decisions difficult. *G.* aff. *margae auctorum* in Texas, I believe, will prove referable to *M. roquei* Pervinquiere. In Texas *Inoceramus undulatoplicatus* Römer occurs in the zone of *Texanites stangeri densicostus* and ranges upward into the zone of *T. texanus texanus*. Wolansky (1932) following Heinz (1928) separated *I. undulatoplicatus* and *I. digitatus* and placed them both in the Emscherian. However, Jeletzky (1958), who uses Coniacian instead of Emscherian, includes *Inoceramus undulatoplicatus* in the zone of *Texanites texanus* [? = *T. texanus gallica* (see Collignon, 1948, who says that there are no true *T. texanus texanus* in Europe)], and in the base of the Santonian. My Texas interpretation thus agrees reasonably well with Jeletzky. It should be pointed out that the difference in larger posterior ribs which Woods (1912) used to differentiate the variety *digitatus* Schlüter from *Inoceramus undulatoplicatus* s.s. is not valid, since topotypes of *I. undulatoplicatus* possess the "*digitatus*" ribbing.

More problems arise at the Santonian-Campanian boundary. Part of these problems result from species interpretation. Europeans, early and late (Grossouvre, 1894, 1901; Haug, 1908–1911; Böse, 1928; Böse and Cavins, 1928; Burckhardt, 1930; Jeletzky, 1951, 1958; Sornay, 1957b; Basse, 1959; Collignon, 1959) have continued to put *Placenticeras syrtale* (Morton) in the Santonian, in spite of the statement by Hyatt (1903) that the European forms did not belong to Morton's species. Scott (1927) in keeping with European usage assigned *Placenticeras syrtale* to the Austin chalk and the Santonian, so that his Taylor could be Campanian, disregarding the statement in Hyatt (1903, p. 206) that the locality and horizon of *P. syrtale* was unknown. Later Scott (1933, p. 59) stated that he had identified *Placenticeras syrtale* and *Scaphites hippocrepis* from the lower Taylor.

Now all European writers except Nowak and a few followers (Nowak, 1916, p. 66, table facing p. 67) include *Scaphites hippocrepis* in the Lower Campanian (Grossouvre, 1894, 1901; Haug, 1908–1911; Jeletzky, 1951, 1955a, 1958, are a few examples). Reeside (1927b, p. 22) said: "In a comparison with figures and descriptions of the European forms referred to *Scaphites hippocrepis* the writer can see no essential differences from the American specimens, and it seems justifiable to use the same name for them, though the writer is skeptical in general as to the validity of such widespread application of specific names."

Stephenson (1923, p. 58, in a quote from Reeside; 1928, p. 492; 1939, p. 548) followed Reeside. Groot, Organist, and Richards (1954, p. 24) among others report *Scaphites hippocrepis* with *Delawarella delawarensis* (Morton); this also tends to support the Campanian age of *S. hippocrepis*. The present status then is: Europeans consistently record *S. hippocrepis* above *Placenticeras syrtale* (Morton). Americans record *Placenticeras syrtale* with *S. hippocrepis*. There are five possible explanations: (1) the zones of *S. hippocrepis* and *Placenticeras syrtale* are not valid for intercontinental correlation; (2) the zone of *S. hippocrepis* is not valid for correlation; (3) the zone of *Placenticeras syrtale* is not valid for correlation; (4) the American *S. hippocrepis* is not the same species as the European *S. hippocrepis;* (5) the European *Placenticeras* *syrtale* is not the same species as the American *Placenticeras syrtale* (Morton) as already stated by Hyatt over 50 years ago (Hyatt, 1903, pp. 191, 237–238).

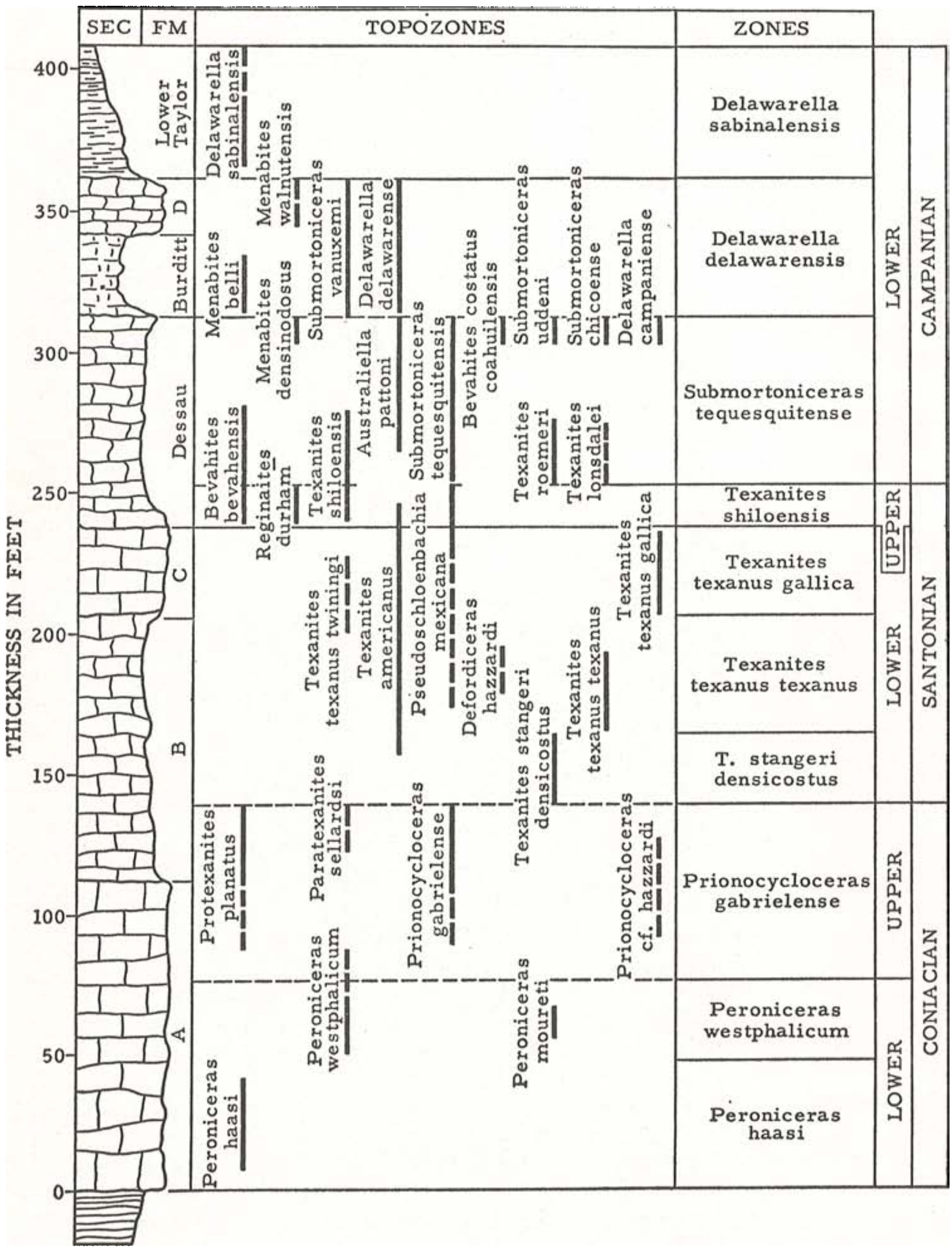
Although my experience with species of *Placenticeras* leads me to believe that we do not yet sufficiently understand them to use them for correlating purposes, I am in agreement with (5) above, that European ammonites should not be assigned to *Placenticeras syrtale* (Morton). Hyatt (1904, p. 191) early pointed to the parallel, but separate, evolution of the nodose species of *Placenticeras* in Europe and America, and his observations concerning the consistently more laterad positioning of the umbilical nodes in the European species are still valid.

Jeletzky (1958) places *Placenticeras guadalupae* in the Middle Santonian, yet Römer's type, in spite of Adkins' (1933, p. 476) conjectures, probably came from the Dessau limestone, zone of *Submortoniceras tequesquitense*, n. sp., just below or with *Scaphites hippocrepis crassus* Reeside, but above *Bevahites bevahensis* Collignon, which Collignon (1948) already places in the top of the Santonian. Hyatt likewise differentiated *P. guadalupae auctorum* (in Europe) from Römer's species, and it is very probable that the European Santonian-Campanian *Placenticeras* represent a separate plexus from the Campanian *Placenticeras* of North America.

Hyatt (1903) indicated that *P. syrtale* was morphologically transitional from normal, smooth, placenticerine species to *P. guadalupae*, but *P. syrtale* in America appears later than *P. guadalupae*. *P. guadalupae*, in America, is long-ranged, ranging from the zone of *Submortoniceras tequesquitense* through the zone of *Delawarella delawarensis* in the San Carlos area of Trans-Pecos Texas, and in northeast Texas, where it occurs in the Gober chalk, and in adjacent Oklahoma (several localities). This latter relationship of *P. guadalupae* and *D. delawarensis* is also true of the Eutaw formation in the Eastern Gulf region if occurrences reported by Stephenson and Monroe (1940, p. 69) are correct. This is one of the reasons I have gone to a zonation using texanitines for as high as such species range, and consequently place *P. guadalupae* (Römer) in the base of the Campanian. By doing this I am following the classification of the Campanian as used by Collignon (1948), who thought he was correlating with Grossouvre (1894, 1901) and Haug (1908–1911). Collignon correlated his zone of *Bevahites bevahensis* (Upper Santonian) with Haug's zone of *Placenticeras "syrtale."* In Texas *Placenticeras guadalupae* (type and type locality) occurs above *Beva-*

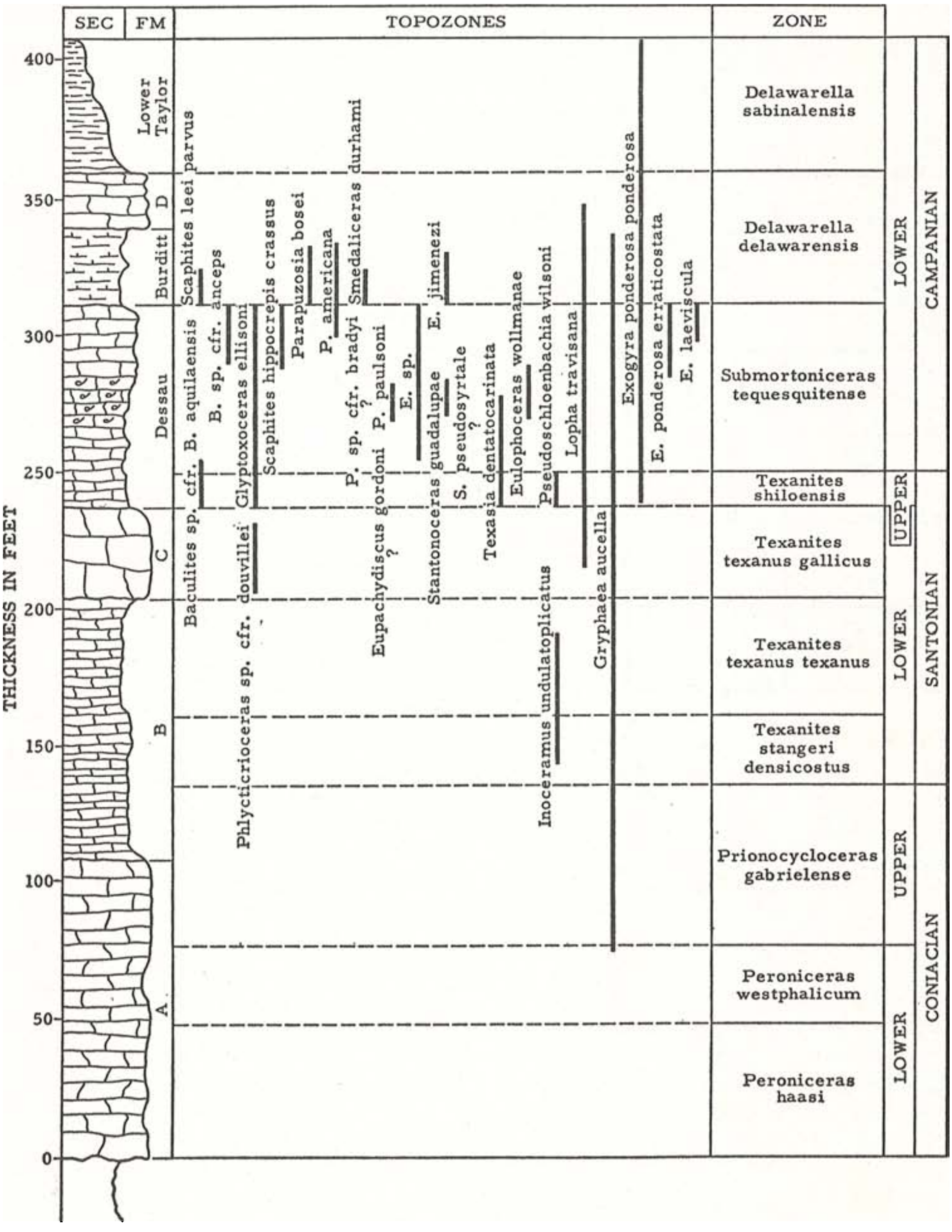
hites bevahensis, but below *Placenticeras syrtale.*

A specimen of *Scaphites leei parvus* Reeside has been found in the Burditt marl, zone of *Delawarella delawarensis*, which, following Collignon (1948) I place in the Lower Campanian. This, of course, disagrees with Cobban (1955, p.



Text fig. 3.—Ranges, known and inferred, of post-Turonian collignoniceratid species in Central Texas, with the corresponding collignoniceratid zonal scheme for the Gulf Coast of the United States.

200) because he not only places the zone of *Desmoscaphites erdmanni* with *Scaphites leei* in the Santonian, he (1955, p. 200) places the overlying Telegraph Creek zone of *Desmoscaphites bassleri* in the Santonian. On the other hand Jeletzky (1955b) would place at least part of the Telegraph Creek formation in the Campanian. Cobban (1955, p. 105) now places the Eagle sandstone (main zone of *Scaph-*



TEXT FIG. 4.—Ranges of ammonoids other than Collignoniceratidae, and ranges of a few important pelecypods, as known in Central Texas, with the corresponding collignoniceratid zonal scheme for the Gulf Coast of the United States.

TABLE 9.—Comparisons of former nomenclatures and correlations of the Austin chalk with present nomenclature and correlation.

FORMATION		STAGES			
This Work	Adkins, 1933	Adkins, 1933	Stephenson, et al., 1942	Young and Marks, 1952	This Work
PECAN GAP	PECAN GAP	CAMPANIAN	CAMPANIAN	CAMPANIAN	UPPER CAMPANIAN
LOWER TAYLOR	LOWER TAYLOR	? UPPER SANTONIAN		UPPER SANTONIAN	
D	BURDITT	LOWER SANTONIAN		LOWER SANTONIAN	LOWER CAMPANIAN
BURDITT			LOWER SANTONIAN		
DESSAU	AUSTIN UPPER				
C	AUSTIN MIDDLE	CONIACIAN	CONIACIAN	?	SANTONIAN
B					
A	AUSTIN LOWER			CONIACIAN	CONIACIAN

ites hippocrepis) in the Campanian, implying a departure from earlier American interpretations of an Upper Santonian Eagle sandstone.

Correlation of the Gulf coast with the standard section.—Young (1960a) has published a premature comparison of the Gulf Coast post-Turonian Cretaceous zonation with that of Europe. In this zonation the base of the *Submortoniceras tequesquitense*, n. sp., (=*S.* sp. aff. *tenuicostulatum* Collignon in Young, 1960a) zone was taken as the base of the Campanian. The selection of the lowest *Submortoniceras* as Campanian follows Spath (1926) and Collignon (1948) (Table 7). In Texas *S. tequesquitense* is the oldest species of this genus, but two other species migrated into Central Texas in the latter part of the zone of *S. tequesquitense* (upper Dessau chalk); these are *S. chicoense* (Trask) and *S. uddeni*, n. sp. All three of these species of *Submortoniceras* occur in the Dessau limestone, as also does *Delawarella campaniensis* (Grossouvre) and *Australiella pattoni*, n. sp. This is certainly a Campanian fauna. Three species of *Texanites* occur with *S. tequesquitense* in the lower part of the *S. tequesquitense* zone; these are *T. shiloensis*, n. sp., *T. roemeri* (Yabe and Shimizu), and *T. lonsdalei*, n. sp. Of these three species of *Texanites* only *T. roemeri* overlaps species of *Submortoniceras* in range other than *S. tequesquitense*, occurring with *Menabites densinodosus* (Renz) at Plymouth Bluff.

Since all of the specimens of *Stantonoceras guadalupae* (Römer) known from Central Texas are from the zone of *Sub-*

TABLE 10.—Distribution chart for 41 species of post-Turonian collignoniceratids for some Gulf Coast localities. The question marks do not represent questionable identifications, but questionable horizons at that locality. For instance, the questioned Lowndes County occurrences denote fossils from the L. C. Johnson collection, U. S. National Museum; for these there is no locality data. The occurrence of *Delawarella delawarensis* in the Mooreville chalk is from Stephenson and Reeside (1938) ; I have not seen the specimen.

	CENTRAL TEXAS											NORTHEAST TEXAS		BIG BEND, TEXAS				UVALDE COUNTY, TEXAS		LOWNDES COUNTY, MISSISSIPPI	
	Lower A	Upper A	Lower B	Upper B	C	Basal Dessau	Middle Dessau	Upper Dessau	Burditt	D	Lower Taylor	Gober	Blossom	Fizzle Flat	Lower Terlingua	Middle Terlingua	Upper Terlingua	Lower Anacacho (=Austin)	Upper Anacacho	Tombigbee	Lower Mooreville
Peroniceras haasi	●																				
P. moureti	?																				
P. westphalicum	●																	●			
Protexanites planatus		●	●																		
Prionocycloceras hazzardi														●							
P. cf. hazzardi		●																			
P. gabrielense		●	●																		
P. cf. guayabanum														●							
Paratexanites sellardsi			●																		
Texanites cf. stangeri														●							
T. stangeri densicostus				●																	
T. americanum				●	●																
T. texanus gallica					●																
Texanites texanus texanus				●																	
T. texanus twiningi																●					
T. shiloense						●														?	
T. lonsdalei							●													?	
T. roemeri							●													●	
Pseudoschloenbachia mexicana						●									●						
P. cf. mexicanum				●																	
Australiella austinense				?																	
A. pattoni								●													
A. welderi																			●		
Defordiceras hazzardi															●						
Bevahites bevahensis						●	●														
B. costatus coahuilaensis								●													
Reginaites durhami							●														
Submortoniceras tequesquitense							●	●													
S. vandaliaense													●								
S. vanuxemi									●			●					●				
S. uddeni									?								●				
S. chicoense																	●				
S. sancarlosense																					?
S. mariscalense																	●				
Menabites densinodosus								?												●	
M. belli									●								?				●
M. walnutensis										●											
Delawarella campaniensis								●													
D. delawarensis										●		●							●		●
D. danei												●									
D. sabinalensis											●								●		

TABLE 11.—Distribution chart for ammonoids other than Collignoniceratidae, and for a few important pelecypods, for some Gulf Coast localities. The question mark signifies a questionable identification.

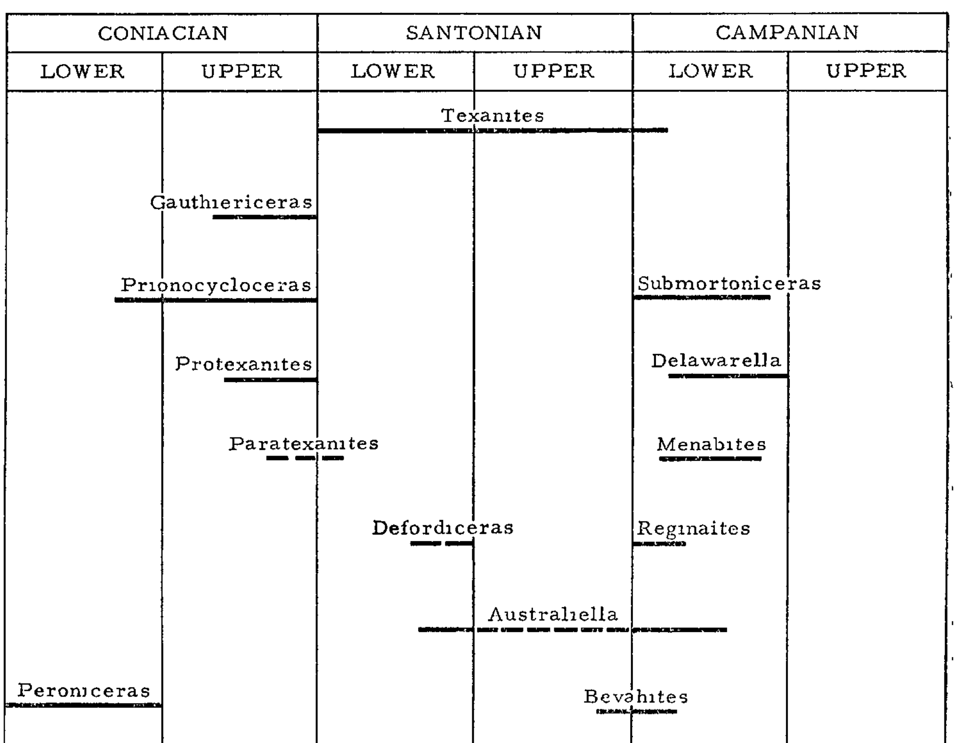
	Formation A (lower)	Formation A (upper)	Formation B (lower)	Formation B (upper)	Formation C	Basal Dessau	Middle Dessau	Upper Dessau	Burditt	Formation D	Lower Taylor clay	Blossom sandstone	Brownstown	Gober chalk	Ozan	Upper Boquillas	Fizzle Flat	Terlingua (lup zone)	Middle Terlingua	Upper Terlingua	Tombigbee sandstone
Baculites sp. cfr. aquilaensis						●															
B. sp. cfr. anceps								●													
Allocrioceras hazzardi																●					
Phlycticrioceras sp. cfr. douvillei					●																
Glyptoxoceras ellisoni						●	●	●					●								
Smedaliceras durhami									●												
Scaphites hippocrepis s. l.								●					●							●	
S. hippocrepis crassus							●														
S. leei parvus									●												
Parapuzosia bosei									●												
P. americana								●	●												
P. sp. cf. bradyi								?													
P. paulsoni							●							●							
Eupachydiscus gordoni					●																
E. jimenezi									●												
E. sp.							●	●													
Muniericeras twiningi																				●	
Placenticeras guadalupae							●										●		●		●
P. sancarlosense																	●		●		
P. pseudosyrtale							●														
Texasia dentatocarinata						●	●												●		
Eulophoceras wollmanae							●														
Pseudoschloenbachia wilsoni						●															
P. sp.																			●		
Inoceramus undulatoplicatus				●														●			
Lopha travisana					●	●		●	●			●	●								
Gryphaea aucella		●	●			●	●	●	●			●	●						●		●
Exogyra ponderosa ponderosa							●	●	●	●	●	●	●	●	●					●	●
E. ponderosa erraticostata							●	●	●				●		●						●
E. ponderosa upatoiensis													●						●	●	
E. laeviuscula								●											●		

mortoniceras tequesquitense, *S. guadalupae*, in the Collignon classification, and also so considered by Wright (Arkell, Kummel, and Wright, 1957), is Lower Campanian. If the *S. guadalupae* and *Scaphites leei parvus* zones are Upper Santonian, then *Submortoniceras tequesquitense*, *S. chicoense*, *S. uddeni*, n. sp., *Australiella pattoni*, and *Delawarella campaniense* are also Upper Santonian (text figs. 3, 4). On the other hand, if the *Stantonoceras guadalupae* zone is Lower Campanian, there is not very much Upper Santonian left in the standard section, and even less in Texas. This is the reason I was tempted to put a zone of *Texanites texanus gallica* in the Upper Santonian (Young, 1960b). This is also the reason that I have indicated that my correlation of the Central Texas zones and the zones of the standard section of the Upper Santonian and Lower Campanian are only tentative (table 7).

I put all but about the lower 20 feet of the Dessau chalk in the Campanian, and also all of the Burditt marl and of formation D. This makes the upper 100 feet or so of the old "upper Austin," at Austin, Lower Campanian. Following the correlations to be made later, the Brownstown formation of Arkansas, the Gober chalk of Texas, the Tombigbee sandstone of Alabama and Mississippi, and the Telegraph Creek formation of Montana would represent approximately the lowest Campanian.

Since the physical stratigraphy of the Austin group is still unpublished I have used the following subdivisions of the Austin group from bottom to top: formations A, B, C, Dessau, Burditt, and formation D. The history of the correlation and nomenclature appears earlier in this work and is summarized in tables 6 and 9. The zones of *Peroniceras haasi*, n. sp., and *Peroniceras westphalicum* (Schlüter) are Lower Coniacian and occur in formation A (text figs. 3, 4). The zone of *Prionocycloceras gabrielense*, n. sp., Upper Coniacian, occupies the upper part of formation A and the lower part of formation B. The zone of *Texanites stangeri densicostus* (Spath) occupies the middle part of formation B, and the zone of *Texanites texanus texanus* (Römer) occupies the upper part of formation B. The zone of *Texanites texanus gallica* Collignon is not well known, but appears to lie in formation C, and according to Collignon (1948) and others is the top of the Lower Santonian. If *T. texanus gallica* is Lower Santonian, instead of Upper Santonian as presented by Young (1960a), most of the Upper Santonian is either missing or has not yet yielded ammonites, or is but a figment of someone's imagination as to the biostratigraphic position of *Stantonoceras guadalupae* (Römer). The base of the overlying Dessau limestone contains the top of the Santonian in the zone of *Texanites shiloensis*, n. sp. The lowest Campanian zone of

TABLE 12.—Ranges of post-Turonian collignoniceratid genera on the Gulf Coast of the United States.



Submortoniceras tequesquitense, n. sp., takes up most of the Dessau chalk, the zone of *Delawarella delawarensis* (Morton) occupies the Burditt marl and formation D, and the zone of *Delawarella sabinalensis*, n. sp., occurs in the base of the lower Taylor clay of Central Texas. I can find no evidence for the occurrence of *Delawarella delawarensis* (Morton) in the lower Taylor clay as reported by Stephenson and Reeside (1938). Such an occurrence would be restricted to the area around Waco, McLennan County, Texas, where the lower Taylor clay replaces the upper part of the Austin of the Austin area. The next recognizable zone overlying the *D. sabinalensis* zone is the basal Upper Campanian zone of *Hoplitoplacenticeras marroti* (Coquand) [=*Hoplitoplacenticeras* sp. aff. *vari* (Adkins, 1933)], which appears in the Pecan Gap–upper Anacacho–Wolfe City–Annona sequence.

Tables 10, 11, and 12 are range charts illustrating the distribution of fossils in some of the formations of the Gulf Coast of the United States.

The following lists of fossils for the various zones are interpretive in that all of the fossils described in this work are included. The positions of some are not actually known by superposition, but are inferred from phylogenetic development or are intercalated from regional stratigraphy. These are marked with an asterisk.

Campanian
- Upper Campanian
  - Zone of *Hoplitoplacenticeras marroti* (Coquand)
    - *Hoplitoplacenticeras marroti* (Coquand)
    - *Hoplitoplacenticeras* sp. aff. *Metaplacenticeras* (?) *bowersi* Anderson
    - *Exogyra ponderosa* Römer
    - *E. ponderosa erraticostata* Stephenson
- Lower Campanian
  - Zone of *Delawarella sabinalense*, n. sp.
    - *Delawarella sabinalense*, n. sp.
    - **Parapuzosia terryi*, n. sp.
    - *Exogyra ponderosa* Römer
  - Zone of *Delawarella delawarensis* (Morton)
    - *Delawarella delawarensis* (Morton)
    - **Submortoniceras mariscalense*, n. sp.
    - *Menabites walnutensis*, n. sp.
    - *M. belli*, n. sp.
    - *Submortoniceras vanuxemi* (Morton)
    - *S. sancarlosense*, n. sp.
    - **S. vandaliaense*, n. sp.
    - **S. candelariae*, n. sp.
    - *Delawarella danei*, n. sp.
    - *Australiella welderi*, n. sp.
    - *Gaudryceras* sp.
    - **Cirroceras reevesi*, n. sp.
    - *Smedaliceras durhami*, n. sp.
    - **Scaphites* cfr. *S. aquisgranensis* Schlüter
    - *Scaphites leei parvus* Reeside
    - *Parapuzosia bösei* Scott and Moore
    - *Parapuzosia paulsoni*, n. sp.
    - *Parapuzosia americana* Scott and Moore
    - *Eupachydiscus jimenezi* (Renz)
    - *Stantonoceras sancarlosense* (Hyatt)
    - **Pseudoschloenbachia chispaensis* Adkins
    - *Lopha travisana* (Stephenson)
    - *Pycnodonte aucella* (Römer)
    - **Pycnodonte convexa* (Say)
    - *Exogyra ponderosa* Römer
  - Zone of *Submortoniceras tequesquitense*, n. sp.
    - *S. tequesquitense*, n. sp.
    - *Bevahites costatus coahuilensis*, n. subsp.
    - *Bevahites bevahensis* (Collignon) (rare)
    - *Menabites densinodosus* (Renz)
    - *Submortoniceras chicoense* (Trask)
    - *S. uddeni*, n. sp.
    - *Delawarella campaniensis* (Grossouvre)
    - *Australiella pattoni*, n. sp.
    - *Texanites lonsdalei*, n. sp.
    - *T. roemeri* (Yabe and Shimizu)

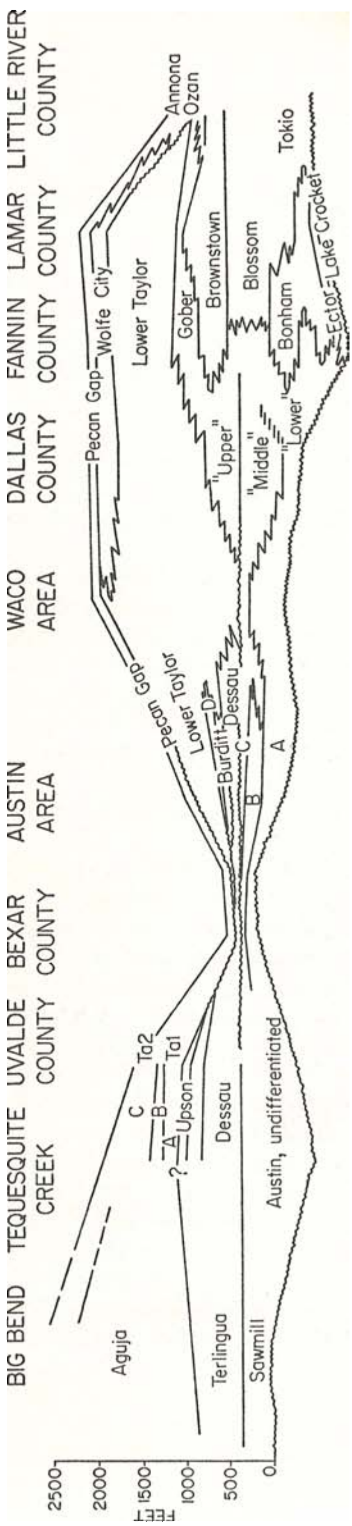
Lower Campanian—*continued*
Zone of *S. tequesquitense* n. sp.—*cont.*
T. shiloensis, n. sp. (rare)
Reginaites durhami, n. sp.
Baculites sp. cfr. *aquilaensis* Reeside
Baculites sp. cfr. *B. anceps* Lamarck
Phlycticrioceras sp. cfr. *douvillei* (Grossouvre)
Scaphites hippocrepis crassus Reeside
**Parapuzosia* sp. aff. *P. bradyi* Miller and Youngquist
P. paulsoni, n. sp.
Menuites ? sp. juv.
Eupachydiscus sp.
Stantonoceras guadalupae (Römer)
S. pseudosyrtale (Hyatt)
Eulophoceras wollmanae, n. sp.
**Pseudoschloenbachia chispaensis* Adkins
P. wilsoni, n. sp.
Pycnodonte aucella (Römer)
Exogyra ponderosa Römer
E. ponderosa erraticostata Stephenson
E. ponderosa upatoiensis Stephenson
E. laeviuscula Römer

Santonian
Upper Santonian
Zone of *Texanites shiloensis,* n. sp.
Texanites shiloensis, n. sp. (abundant)
Bevahites bevahensis Collignon (abundant)
Pseudoschloenbachia mexicana (Renz)
Texasia dentatocarinata (Römer)
Lopha travisana (Stephenson)
Lower Santonian
Zone of *Texanites texanus gallica* Collignon
**Texanites texanus gallica* Collignon
T. texanus twiningi, n. subsp.
T. americanus (Lasswitz)
**Phlycticrioceras* sp. cfr. *P. douvillei* (Grossouvre)
**Eupachydiscus gordoni,* n. sp.
Lopha travisana (Stepenson)
**Muniericeras twiningi,* n. sp.
Pycnodonte aucella (Römer)
Zone of *Texanites texanus texanus* (Römer)
Texanites texanus texanus (Römer)
Pseudoschloenbachia mexicana (Renz)
**P.* sp. juv. aff. *mexicana* (Renz)
**Australiella austinensis,* n. sp.
**Defordiceras hazzardi,* n. gen. and n. sp.
Inoceramus undulatoplicatus Römer
Pycnodonte aucella (Römer)

Coniacian
Upper Coniacian
Zone of *Prionocycloceras gabrielense,* n. sp.
Prionocycloceras gabrielense, n. sp.
**P.* sp. aff. *guayabanum* (Steinmann)
P. hazzardi, n. sp.
Parabevahites sellardsi, n. sp.
Protexanites planatus (Lasswitz)
Pycnodonte aucella (Römer)
Lower Coniacian
Zone of *Peroniceras westphalicum* (Schlüter)
P. westphalicum (Schlüter)
P. moureti Grossouvre
**Prionocycloceras adkinsae,* n. sp.
Zone of *Peroniceras haasi,* n. sp.
P. haasi, n. sp.
Coilopoceras austinense Adkins

Gulf Coast Correlations

Most of the areas of the Gulf Coast have not been as thoroughly collected as the Central Texas area for which the more detailed zonation is given in tables 10 and 11. Detailed correlations are as yet impracticable for the entire area. The amount of cover and the consequently limited outcrops may even preclude any detailed outcrop correlations in the future. However, a tentative correlation is given for Texas in text fig. 5, and for the Gulf Coast in table 13. Furthermore, the reader may draw his own conclusions from the distribution charts given in tables 10 and 11.



TEXT FIG. 5.—Diagrammatic chart correlating various formations between the unconformity at the base of the Austin group and the Pecan Gap-Wolfe City and equivalent strata.

Lowndes County, Mississippi.—There is a very important classic section at Plymouth Bluff, and in the vicinity of Plymouth Bluff, Lowndes County, Mississippi. The correlation of this section, I believe, has been misinterpreted. *Exogyra ponderosa* occurs in the Tombigbee sandstone in Mississippi (Stephenson and Monroe, 1940, p. 69). This species first appears in the zone of *Submortoniceras tequesquitense*, n. sp., about 20 feet above the base of the Dessau limestone in central Texas. Bed 4 of the Tombigbee sandstone at Plymouth Bluff contains *Menabites densinodosus* (Renz) (=*Mortoniceras* aff. *M. texanum* Römer in Stephenson and Monroe, pl. 3, fig. 1, 1940). Haas (1942) first noticed the similarity of Renz's species with the fossil illustrated by Stephenson and Monroe. *M. densinodosus* occurs in the *Exogyra laeviuscula* beds in Uvalde County, and should correlate with the upper part of the zone of *Submortoniceras tequesquitense* and/or the lower part of the zone of *Delawarella delawarensis*, upper Dessau limestone or lower Burditt marl. I have not seen the fossil reported by Stephenson and Monroe (1940) as "*Mortoniceras*" *delawarense*, reported by them to be also from bed 4 at Plymouth Bluff. However, two ammonites in the Adkins collection, one of which is illustrated on pl. 43, fig. 1, from bed 4 at Plymouth Bluff, seem to belong to *Texanites roemeri* (Yabe and Shimizu), which species occurs in the *Submortoniceras tequesquitense* zone of the Dessau limestone. *T. roemeri* had already been recorded above *T. texanus* by Fehr (in Burckhardt, 1930, p. 225). *Placenticeras planum* and *Stantonoceras* aff. *S. guadalupae*, reported from the Tombigbee sandstone (Stephenson and Monroe, 1940) would also be expected from the zone of *S. tequesquitense* or from the zone of *Delawarella delawarensis*. The holotype of *S. guadalupae* (Römer) almost certainly came from the Dessau limestone, and in 1959 Miss Constance Wollman collected two nice specimens of this species from the Dessau limestone, the only individuals of the species to be collected from Central Texas, besides the holotype.

Marsupites americanus (Springer) also comes from bed 4 at Plymouth Bluff. Marks (1952) reported this crinoid from the *Exogyra laeviuscula* bed at the top of the Dessau limestone, and he correlated the Tombigbee and Mooreville with the *Exogyra laeviuscula* and *Terebratulina guadalupae* subzones in the Dessau. Rather than compare the zone of *Marsupites americanus* to the Santonian *M. testudinarius*, agewise, it compares much better to the zone of *M. ornatus* as given by Jeletzky (1958).

It seems almost certain, now, that at least the upper part of the Dessau limestone correlates with the lower Tombigbee sandstone at Plymouth Bluff (table 13), and that the Burditt and formation D correlate with the upper Tombigbee sandstone and with the lower beds of the Selma chalk in Lowndes County, and with the Mooreville. Thus Stephenson's (1937) zones of "*Gryphaea*" "*wratheri*" in the Tombigbee and upper Austin may be more nearly synchronous than he originally thought. Fossils common to the Tombigbee sandstone and the Dessau limestone are:

Texanites roemeri (Yabe and Shimizu)
Menabites densinodosus (Renz)
Pycnodonte aucella (Römer) [=*Gryphaea wratheri* Stephenson]
Marsupites americanus Springer
Stantonoceras guadalupae (Römer)
Exogyra ponderosa Römer (first appearance)
E. ponderosa erraticostata Stephenson (first appearance)

Southwestern Arkansas and adjacent Oklahoma.—*Exogyra ponderosa* appears first in the base of the Brownstown marl (Dane, 1929), and Stephenson (1937) reports *Lopha travisana* from the base of the Brownstown, which would more likely represent the *L. travisana* zone at the base of the Dessau chalk (Young and Marks, 1952) than the *L. travisana* zone of the Burditt. Further substantiation of this is the report by Stephenson of *S. hippocrepis* in the Brownstown. *S. hippocrepis crassus* Reeside is known from the Dessau in Travis County. *Scaphites hippocrepis* also occurs in the Ozan, as does *Delawarella danei*, n. sp. (=*Mortoniceras delawarense* Dane, 1929, pl. 10, figs. 1 and 2). The Brownstown then correlates with the Dessau limestone and the Ozan correlates with the Burditt marl and formation D. This correlation makes the Brownstown-Ozan unconformity (Stephenson, *et al.*, 1942) rather unimportant. R. T. Hazzard and Oscar Paulson have collected *Delawarella delawarensis* (Morton) and *D. danei* along with *Submortoniceras vanuxemi* (Morton) from the Gober chalk in Lamar County

TABLE 13.—Tentative correlation of Coniacian, Santonian, and Lower Campanian formations from Central Texas, Northeast Texas, Arkansas, and Mississippi.

Stage	Central Texas	Northeast Texas	Arkansas	Mississippi
Upper Campanian	Pecan Gap	Pecan Gap Wolfe City	Annona	Tupelo
Lower Campanian	Lower Taylor	Lower Taylor	Ozan	
	"D"	Gober		Mooreville
	Burditt			
	Dessau	Brownstown	Brownstown	Tombigbee
Santonian	"C"	Blossom	Tokio	
	"B"	Bonham		Lower Eutaw
Coniacian	"A"	Ector		

and from equivalents of the Gober chalk in McCurtain County, Oklahoma, and it is now suggested that the Gober chalk correlates with the Ozan of southwest Arkansas, the basal beds of the Selma in Lowndes County, Mississippi, and with the Burditt marl and formation D of Central Texas. The uppermost Blossom sand, with *Exogyra ponderosa* Römer would then correlate with the Dessau limestone, although the presence of *S. vandaliaense*, n. sp., an advanced *Submortoniceras,* indicates that probably a Blossom lithostrome occurs at a higher level than heretofore suspected. *S. vandaliaense* is from an area at the southern edge of the outcrop of the Blossom as mapped (Stephenson, 1937), on Pecan Bayou, south of Vandalia, and indicates a younger sand facies in the Red River County area.

There is also a peculiar *Placenticeras* fauna associated with the *Delawarella* fauna in northeast Texas, Lowndes County, Mississippi, and in the San Carlos area of Trans-Pecos Texas. This includes *Stantonoceras guadalupae* (Römer), *S. sancarlosense* (Hyatt), *Placenticeras planum* Hyatt, and early *P. meeki* Böhm. Two unusual morphotypes, one of which is probably *Placenticeras costatum* Johnson (1904), that have always been included in *P. planum,* s. l., are also present at both Lowndes County and in the San Carlos area. In addition the peculiar *Exogyra* called *E. ponderosa* variety by Dane (1929, pl. 9, fig. 2 only), occurs in the Brownstown marl and in equivalent beds in the San Carlos area, and in the east front of the Davis Mountains, Trans-Pecos Texas. This form is considered a special variant of *E. ponderosa upatoiensis* Stephenson. Although Stephenson (1937) intended to use his pelecypod zones, most of his dating of the phosphate nodule levels which he considers so important are based on foraminiferal identifications by Cushman. He quotes Cushman as giving an Austin age identification to Burditt marl foraminifers. Helen Plummer (1949) gives no description, but shows by table the tremendous difference between lower Taylor and Pecan Gap foraminiferal suites. In addition Helen Plummer (in Marks, 1950) in discussing a Burditt fauna from the San Gabriel River in southern Williamson County, can find only two species that do not occur in the fauna of the lower Taylor clay. This fauna was collected about 20 feet above the *Parapuzosia bösei* bed at water level of the San Gabriel River. One of the greatest differences in foraminiferal lists of lower Taylor and Austin faunas is ecological—that is the difference between faunas of carbonate bottoms and faunas of clay bottoms. Frizzell (1954) in discussing the Austin-Taylor boundary, follows Stephenson, *et al.* (1942), in his chart and first part of the discussion, but indicates the possibility of a lithosomal relationship between the two formations with the following statement, "An alternative hypothesis may be suggested, based on the ranges of distinctive Foraminifera, that the basal Taylor and highest Austin strata are equivalent." Further evidence of the equivalence of Gober-Dessau-Burditt is the occurrence of *Parapuzosia paulsoni,* n. sp. in the Gober and the Dessau.

Correlation with the Western Interior.—Stephenson and Reeside (1938) made the basic correlation from the Gulf Coast to the Western Interior. In this paper the essential correlation of the Tombigbee sandstone with the upper part of the Austin chalk is pointed out. Also Stephenson and Reeside report *Mortoniceras* aff. *delawarense* (Morton) from the lower Taylor in this paper. I have not been able to verify this specimen, but this species does occur in the upper Burditt (of Adkins), formation D of this work, and in the Gober chalk. Since only a few ammonites occur in both the Austin group and in the Western Interior, I will limit myself to a few remarks concerning fig. 2 of Stephenson and Reeside (1938).

As I have now correlated the Ozan, the Burditt, and formation D with the Gober, either the Ozan must come down on the diagram of Stephenson and Reeside (1938, fig. 2) or the others must go up. It is now my opinion that all of these formations are Lower Campanian and probably correlate with the Eagle sandstone on the basis of *Baculites* cf. *aquilaensis* Reeside and *Scaphites hippocrepis crassus* Reeside from the upper Dessau chalk. The large parapuzosiines from the Burditt and the upper Austin chalk in the Dallas area (Clark, 1960), especially *Parapuzosia americana* Scott and Moore, are closely related to *Parapuzosia bradyi* Miller and Youngquist from the Eagle sandstone.

Some questions arise from such a correlation. Cobban and Reeside (1952, p. 1019) report *Inoceramus undulatoplicatus* Römer as occurring with *Placenticeras guadalupae* (Römer). In Central Texas, as well as in Trans-Pecos Texas, *I. undulatoplicatus* occurs fully two zones below *P. guadalupae*. This either means that one or the other or both of these species are of no value for correlation; or that *Inoceramus undulatoplicatus* ranges higher in the Western Interior; or that *P. guadalupae* ranges lower in the Western Interior. Another explanation is that an *Inoceramus* in the Western Interior is a homeomorph of *Inoceramus undulatoplicatus* just as *I. schmidti* is a homeomorph of *I. digitatus* (Matsumoto, 1960). *Baculites* sp. cfr. *aquilaensis* Reeside is known now from the Dessau, and *Scaphites leei parvus* Reeside is known from the Burditt. Species in common or with near analogues in the Dessau and Telegraph Creek are *Baculites aquilaensis* s. l., and *Scaphites leei* s. l. Species or near analogues common to the Dessau-Burditt and the Eagle sandstone are *Scaphites hippocrepis* s. l., *Baculites aquilaensis, Parapuzosia americana*, and *Parapuzosia bradyi*. Reeside (1927a, p. 32) notices that Stephenson reports *Placenticeras planum* from the *Mortoniceras texanus* subzone of the eastern Gulf Coast, and points out that this is an older occurrence than that of the Western Interior occurrences. However, since Stephenson misidentified *Mortoniceras texanum*, Reeside's dating of the eastern Gulf Coast is also in error, because Stephenson's *M. texanum* subzone contains *Menabites densinodosus* (Renz) and *Texanites roemeri* (Yabe and Shimizu) both of which are known from the *Submortoniceras tequesquitense* zone of the Dessau formation, from which the holotype and two other individuals of *Placenticeras guadalupae* (Römer) were collected. Many *P. guadalupae* and *P. planum* occur together at many localities in Trans-Pecos Texas and adjacent Chihuahua, as already reported by Hyatt (1903).

Summary.—My Campanian dating of the Dessau limestone, Burditt marl, Gober chalk, Ozan formation, "upper" Austin of the Dallas area, Tombigbee sandstone, Eagle sandstone, and at least part of the Telegraph Creek formation has already been forecast by Jeletzky (1955b) who on less sound, but none-the-less reasonable grounds, argues for the Campanian age of the *Hesperornis* beds of the Niobrara formation and at least the upper part of the Telegraph Creek formation. I am not now convinced that the Santonian age of the zone of *Desmoscaphites bassleri* can be maintained, especially since *Scaphites hippocrepis* is consistently classified as Campanian. Wright (Arkell, Kummell, and Wright, 1957) also anticipates my correlation by dating *Placenticeras guadalupae* (Römer) as Campanian.

Reeside's earlier correlations were based largely on scaphitines, and it was only natural that he should have followed the lead of Nowak (1916) and Frech (1915) to whom he referred regularly concerning the classification of the scaphitines. Nowak and Frech both referred *Scaphites hippocrepis* to the Santonian, and Reeside followed their lead. Nowak (1916, chart facing p. 67) even refers *S. hippocrepis* to the zones of *Placenticeras syrtale* and *Texanites texanus*. This is no longer done (Jeletzky, 1951, 1955a, 1955b, 1958), nor was it done by Grossouvre (1894, 1901) or Haug (1908–1911).

Matsumoto (1959b, pp. 67–68; 1960, pp. 43–44) has discussed the correlations between Japan and California and Texas.

The only thing to be added here is the occurrence of *Submortoniceras chicoense* (Trask) in the zone of *Delawarella delawarense,* and the occurrence of *Hoplitoplacenticeras* sp. aff. *Metaplacenticeras* (?) *bowersi* Anderson in the Pecan Gap chalk zone of *H. marroti.*

Reiss (1952, p. 46) anticipated the present correlation, but assumed that if the Méndez were Maestrichtian, then the Papagallos would be Campanian, but most authors will not follow Reiss in assuming different ages for the Papagallos and Méndez. Furthermore, the Lower Campanian age of the upper San Felípe seems to be established by its producing *Eupachydiscus jimenezi* (Renz) and *Bevahites costatus coahuilaensis,* n. subsp. In the collection with these two species are also several specimens of *Exogyra tigrina* Stephenson, which is characteristic of the very top of the Dessau limestone. This faunule is from Arroyo Tecolote in the vicinity of Jiménez, Coahuila. *Eupachydiscus jimenezi* (Renz) and *Parapuzosia bösei* (=P. *corbarica* Renz, *non* Grossouvre) also indicate a Campanian age for the "Austin" beds from which they were collected near Jiménez. Actually the Jiménez localities are in the area of the San Juan limestone of Dumble (1915) which Imlay (1944) puts in synonymy with the Austin chalk, but which most Mexican geologists prefer to call San Felípe.

Techniques

Illustrations.—The reader will find, unfortunately, that the illustrations of a single species are not always grouped together, but for some species at least are scattered through several widely separated plates. With the smaller pictures filling the spaces between larger pictures on plates, the number of plates and hence the total plate cost has been reduced considerably. But pictures of some ammonites are widely scattered through the plates.

Most of the fossils have been whitened before photography. For most of these an ammonium chloride generator heated by an electric coil was used. Before coating with ammonium chloride the fossils were heated and dried in an oven to prevent graininess as a result of hygroscopy of the ammonium chloride. However, on fossils as large as some of the species of *Submortoniceras* and *Prionocycloceras*, it is not possible to spread an even coat of ammonium chloride. For these a white, water soluble poster paint was used. For smaller fossils, or when detail is desired, poster paint is impractical because it produces a thick coating, obscuring the fine detail. Also, if the fossil is porous, bubbles are produced when the air escapes from the fossil as it is replaced by the paint. For most large fossils poster paint is quite satisfactory, especially if illustrated at reduced dimensions.

Some authors illustrate whorl sections accurately drawn from sectioned specimens. The whorl sections are then distorted or not distorted, depending on the distortion or lack of distortion of the fossil. With a very few specimens representing each taxon, it was not desirable to section fossils. I have tried to remove the distortion from most of the whorl sections, and the whorl sections then become interpretations. Furthermore, one flank of a fossil is usually much more badly weathered than the other. Under such circumstances I have reproduced the section of the well preserved flank and drawn the other flank as its mirror image. This also results in interpretation, but not any interpretation that will produce serious error. More serious interpretations are the attempts at restoration of whorl width for the whorl sections of crushed steinkerns. When such restoration is made it is indicated in the figure descriptions.

Mensuration.—The measurements of ammonites have only a qualitative meaning, unfortunately, because they have been approached only in a qualitative way. Furthermore, the distortions of many carbonate internal molds produce measurements far more variable than in undistorted forms. The standard measurements used by ammonitologists show considerable variation within a species, but part of this is probably the result of collections of samples from more than one zoological (geographical) population. In other words a good deal of evolution (variation in time) is included in the samples measured. I am using the abbreviations D (for diameter of conch), U (for diameter of umbilicus), HF (for height of whorl from umbilical suture to the base of the keel), W (for width of whorl), and HF/W (a ratio of height of whorl to width of whorl). Haas's (1942) symbols are more pleasing, but the ones I started to use (Young, 1957) have the advantage to the printer of not employing subscripts or superscripts. HF is the same as Haas's H′, except HF is measured to the base of the keel. On most of the Texas steinkerns the height of the keel has to be estimated because of erosion and H cannot be consistently measured. The H measurement of most authors is a better measurement, but requires sectioning of the fossils to obtain consistently accurate figures.

Costation is given for definite diameters in number of ribs or costae per volution. The following counts are given: P (for primary costae), S (for secondary costae), B (for number of bifurcating pairs), and T (for total number). On most pages these figures follow in order the above figures of mensuration. P, S, B, and T are true numbers. D is given in mm., and as is customary in ammonite description, U, HF, and W are given in percentages of D. HF/W is a ratio.

In written descriptions sparsely costate conchs are those with less than 20 ribs per volution, moderately costate conchs are those with 20 to 30 ribs per volution, and densely costate (densicostate) conchs are those with more than 30 ribs (costae) per volution. I have tried to follow the tuberculation nomenclature of Arkell, Kummel and Wright (1957), and have with one exception. Their nomenclature leaves one without an all-inclusive term for nodes, clavae, bullae, etc. I have used tubercles for this all-inclusive term, in addition to the specialized usage. Horns refer to large, tubercle-like protuberances. Otherwise my terminology is that of Spath (1923).

The scatter plots, such as text fig. 16, are an experiment. For many species the samples are not large enough to validate the specific characters. However, interesting "trends" in evolution are demonstrated when the scatter plots for the different species are compared.

PERONICERATINAE

Collignon (1948) was extremely doubtful of the derivation of the Texanitinae from the Collignoniceratidae, and Haas (1942, 1948) considered a supposed dipolocerine ancestry of the Texanitinae worth discussion, and discrediting, in spite of Spath's (1921a) and Roman's (1938) earlier assignments to the "Prionotropidae." It is now apparent that the question is not of derivation of Texanitinae from Collignoniceratidae Wright and Wright (= Prionotropidae *pro parte* Spath, 1921a, and Roman, 1938), but of how many separate collignonicerid lineages may be represented in the Texanitinae as used by Wright (Arkell, Kummel, and Wright, 1957) and in the Peroniceratinae. Although dating and phylogeny, as pointed out by Jeletzky (1955), would be much improved if a plexus similar to his *Belemnitella praecurser* plexus were established, I am as yet unable to work my way through the maze of taxa to produce such a plexus. I am not even able to reach satisfactory conclusions on the evolutionary lineages in the Peroniceratinae and Texanitinae, for several reasons. Nearly all of the Austin chalk fossils are so large that they defy comparison with most of the species described from elsewhere. There is little chance, for example, of comparing the large *Prionocycloceras gabrielense*, n. sp., (D = 365 mm.) or *Prionocycloceras hazzardi*, n. sp. (D = 520 mm.), with *Prionocycloceras lenti* (Gerhardt, 1897) as illustrated by Reyment (1958b, pl. 3, figs. 1ab). Even more impossible would be a comparison with the individuals illustrated by Basse (1951) and Besaire (1936) or a comparison with *Prionocycloceras maarfiaense* Sornay (1957a, pl. 16, figs. 8 and 11) or *Prionocycloceras* (?) *recticostatum* Sornay (1957a, pl. 16, fig. 7). Consequently some of the new species described herein could be the adults of previously described species. But it is impossible to select a previously described species for synonymy, if any such correspondence does exist. The description of new species is much preferred to any game of guessing that would be required by such dubious comparisons.

It is surprising how few of the Austin chalk ammonites had heretofore been described. Adkins (1933) did not miss many, but they are all listed by aff. or cf., and it is now difficult to know which specimen he was referring to when he said "*Peroniceras* aff. *westphalicum*" or "*Mortoniceras* aff. *emschere*." Some of the gaps in ammonite evolution have been partly filled by a study of the Austin chalk ammonites, but probably more questions have been posed than answered. There are no new annectents in the genus *Peroniceras*, and the different species of *Peroniceras* seem to be just as well delineated as heretofore. However, annectent forms occur in the genera *Protexanites* and *Prionocycloceras*. The large *Prionocycloceras gabrielense*, n. sp., has some features of *Protex-*

anites and some features of *Prionocycloceras*, just as the smaller *Prionocycloceras adkinsae*, n. sp., has some features of each of *Prionocycloceras*, *Protexanites*, and *Australiella*. Certainly some species of *Australiella* Collignon are derived from *Protexanites* or *Prionocycloceras* directly through some such species as *Prionocycloceras adkinsae*, n. sp., or an ancestor of *Protexanites shoshonense* (Meek) before the median tubercle was developed. However, I cannot satisfy myself as to the origin of the type species of the genus *Australiella*, *A. australis* (Collignon). If *A. australis* actually is related to *Delawarella* and *Menabites*, then *A. austinensis*, n. sp., should be ascribed to a new genus (Adkins, 1933, p. 407, proposed the *nomen nudum*, *Austinites*, for this species), or should be assigned to *Prionocycloceras*, extending the range of that genus into the Santonian.

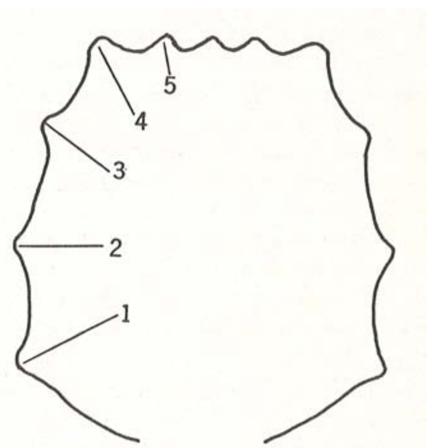
The adult of *Prionocycloceras hazzardi*, n. sp., is an extremely unusual bituberculate form, and some of the old labels read "*Mammites*," which genus it certainly recalls.

Barroisiceratinae

Pseudoschloenbachia mexicana (Renz) is very close to *P. bertrandi* (Grossouvre). If it is a true *Pseudoschloenbachia* then there may be a *Pseudoschloenbachia* lineage from *Gauthiericeras*; juveniles of this species (Pl. 30, figs. 1, 5, 8) in the Adkins collection are labeled "*Gauthiericeras* cf. *margae*," and they certainly look like *G. margae*. The derivation of *Pseudoschloenbachia* is a particularly knotty problem as indicated by Wright (Arkell, Kummel, and Wright, 1957) when he questionably assigned it to the Lenticeratinae. It is possible that the present concept of the genus *Pseudoschloenbachia* carries two or more lineages. Certainly one lineage is from *Gauthiericeras*, probably through a barroisicerine stock, and there may be another from some lenticerine or barroisicerine stock. Furthermore, with our limited state of knowledge, other *Pseudoschloenbachia* could be descended from some late Cenomanian or early Turonian schloenbachiine similar to *Schloenbachia glabra* Spath (1926) (= *Ammonites goupilianus* Sharpe, 1857, pl. 17, figs. 5ab) (Wright and Wright, 1951, p. 23). Such forms occur in South America (Bürgl, 1957, pl. 12, figs. 3ab) and younger ones occur with *Lewesiceras* sp. in Venezuela. These could even be a bridge to *Niceforoceras* and later pseudoschloenbachiines, either direct or through less ornate species of *Prionocycloceras*. Again, in spite of Jeletzky's (1955a) encouragement, I cannot find the plexus for the pseudoschloenbachiines, and I really suspect that three plexi are involved. Whatever the phylogeny, the present taxonomy only serves to make it more obscure, since the present taxonomy is horizontal.

Texanitinae

Texanitine Tuberculation. — Collignon (1948) discussed the texanitine tuberculation, and I am following his terminology (text fig. 6). The umbilical tubercle is the first tubercle or number 1. The flank tubercle or lateral tubercle is number 2. Number 3 is the submarginal tubercle which is situated high on the flank between



Text fig. 6.—Whorl section of a texanitid. The tubercles are numbered according to the Collignon (1948) classification. Tubercle no. 1 is the unbilical, no. 2 is the lateral, no. 3 is the submarginal, no. 4 is the marginal (shoulder), and no. 5 is the external (texanitine).

the lateral tubercle and the ventrolateral tubercle. The ventrolateral or shoulder tubercle is called marginal by Collignon; it is number 4. Number 5 is the external clava, or texanitine clava, which is so diagnostic of the subfamily Texanitinae Collignon.

This is purely a morphological classification, since in not all of the taxa is the derivation of the texanitine (or other) tubercles known. In some it seems to be derived from the shoulder tubercle of collignoniceratines by the insertion of the marginal, as in *Prionocycloceras guayabanum* (Steinmann in Gerhardt). In other taxa the texanitine clava appears to be derived by the breaking up of the lateral keels of *Peroniceras*. It is also possible that the texanitine and marginal clava of some texanitines are derived directly from the two shoulder tubercles of other, earlier collignoniceratines.

However the derivation of the tubercles, the Collignon classification is practical and useful in discussions of the morphologies and derivations of Collignoniceratidae.

Texanitinae.—In 1957 Reyment described *Peroniceras* (*Reginaites*) *quadrituberculatus*, with the subgenus *Reginaites* new. This subgenus was described as a *Peroniceras* with more than the normal two tubercles (umbilical and ventrolateral) of *Peroniceras s. s.* Reyment suggested a questionable Coniacian age for *Reginaites*, but at the same time assigned to his new subgenus the Lower Campanian *Peroniceras leei* Reeside. It is no collecting accident that *Peroniceras leei* was reported (Reeside, 1927a) with *Stantonoceras guadalupae* (Römer), *S. sancarlosense* Hyatt, *Placenticeras planum* Hyatt, *P. newberryi* Hyatt, etc. Because of the association with *Texanites omeraensis* Reeside this fauna may be Upper Santonian, but it has more of a Lower Campanian aspect, and *Texanites omeraensis* may be no more than a geographic subspecies of the Campanian *T. roemeri* (Yabe and Shimizu). *Reginaites durhami*, n. sp., is from the top of the Santonian or the base of the Campanian, occurring with *Bevahites bevahensis* Collignon and *Texanites shiloensis*, n. sp., at a horizon low in the zone of *Submortoniceras tequesquitense*. *Reginaites durhami* has elongate texanitine clavae on the young whorls, which coalesce to produce the tricarinate *Reginaites* adult. Because of the ontogeny of the texanitine clavae in *Reginaites durhami* and the upper Santonian or lower Campanian age of *Reginaites durhami* and the Lower Campanian (or at least the youngest Upper Santonian) age of *Reginaites leei* (Reeside), I am deriving *Reginaites* Reyment from some Lower Santonian ammonite such as *Texanites stangeri* (Baily) and removing the genus from subgeneric status under *Peroniceras* and from the Peroniceratinae, placing it in the Texanitinae. If it must be a subgenus, it is a subgenus of *Texanites*. *Reginaites* is apparently one of Arkell's (1951) "dead-end off-shoots" to which Jeletzky (1955a) would not give generic status.

I have already discussed the derivation of *Australiella*, without any satisfactory conclusion, and the removal of *Reginaites* Reyment from the Peroniceratinae to the Texanitinae. I have nothing new to add to the statements of Collignon (1948) concerning the development and derivation of *Texanites* Spath. The Texas material of *Menabites*, *Bevahites*, and *Delawarella* is much too meager and poorly preserved to yield any information concerning the development and derivation of these genera, and *Bererella* is still unknown in North America. It should be pointed out that the marginal and submarginal (3rd and 4th) tubercles of nearly all individuals of *Delawarella delawarensis* (Morton) are more closely spaced than any other pair of tubercles. Whether this indicates a bevahitine relationship I do not know, because the same close spacing of marginal and submarginal tubercles is also typical of some individuals of *Submortoniceras vanuxemi* (Morton) and *S. tequesquitense*, n. sp., which seem more likely derived by caenogenesis from some species of *Texanites* such as *T. shiloensis*, n. sp., (juveniles illustrated on pl. 54, figs. 4–7, and pl. 70, fig. 6). The genus *Texanites* has definite Lower Campanian representatives in the Gulf Coast in *Texanites roemeri* (Yabe and Shimizu) and *T. lonsdalei*, n. sp.

Submortoniceras could be split up as the other texanitines have been, but there seems to be little practical reason for such splitting, unless a lineage should prove to have arisen outside of the genus *Texanites*. There are three species groups in *Submortoniceras*: (1) the species group of *Submortoniceras chicoense* (Trask); (2) the species group of *Submortoniceras woodsi* Spath; and (3) the species group of *Submortoniceras soutoni* (Baily).

Submortoniceras chicoense (Trask) appears to be derived from *Texanites* through some species similar to *Submortoniceras propoetidum* (Redtenbacher) which leads through *S. chicoense* and *S. rennei* Collignon to *S. uddeni*, n. sp., to an end product of *S. mariscalense*, n. sp. However, *S. uddeni* is lowest Campanian, so that the morphological sequence does not agree with the known superposition. *S. mariscalense* is from higher in the Lower Campanian so that age relationships agree with morphological transition as far as this species is concerned.

S. woodsi Spath appears to be descended from *Texanites* through species like *S. propoetidum* (Redtenbacher) or *S. tenuicostulatum* Collignon to *S. vanuxemi* (Morton) to *S. woodsi* Spath, to *S. sancarlosense*, n. sp., to *S. vandaliaense*, n. sp.

For both the groups of *S. woodsi* and *S. chicoense* the morphological sequence is clear, and for the group of *S. woodsi* the morphological sequence is well supported in Texas, at least, by the additional evidence of superposition of the proper morphologies. For the group of *S. chicoense*, although the morphological sequence is rather complete, the superposition is not well enough demonstrated to either support or deny phylogenetic inferences drawn from the morphological sequence.

The group of *Submortoniceras soutoni* (Baily) is less well known than the other two species groups of *Submortoniceras*, and Haas (1942) and Collignon (1948) have included Baily's species in *Texanites*, whereas Spath (1953) still insists on the genus *Submortoniceras* for "*Ammonites*" *soutoni* Baily. I am inclined to agree with Spath because *S. soutoni* (Baily) seems almost certainly to be related to a species that I have had an opportunity to study, *S. candelariae*, n. sp. Granting that the morphological sequence is incomplete, and that the superpositional sequence is unknown, it seems most plausible to me to derive the group of *Submortoniceras soutoni* from variants of *S. vanuxemi* which are not as compressed as the normal (pl. 56, fig. 2) and in which the flank (second) tubercle is effaced or at least ephemeral at diameters of 50 to 100 mm. Although agreeing with Haas (1942) and Collignon (1948) that Woods's (1906) species (*Submortoniceras soutoni* Woods, non *Ammonites soutoni* Baily) does not belong to Baily's *Submortoniceras soutoni*, I am not convinced, from Woods's illustrations, that it does not belong to that group, possibly being a more coarsely costate form of *S. candelariae*, n. sp. Woods's species also has somewhat the appearance of the high-whorled *Texanites roemeri* (Yabe and Shimizu). I have assigned Collignon's (1948) *Texanites* sp. aff. *soutoni* to the new species *Texanites lonsdalei*.

Matsumoto (1960, p. 163) proposes to make *Delawarella* Collignon a subgenus of *Submortoniceras* Spath. I do not follow him in this because I believe that the two genera have different phylogenies, descended from different lines, though each may be descended from some species of *Texanites*. Like *Reginaites*, *Bevahites* may also represent one of the "dead-end offshoots" of Arkell (1951).

HETEROMORPHA

Little basic paleontology can be done on the heteromorphs in Texas. In the Austin group occur *Phlycticrioceras*, *Allocrioceras*, *Bostrychoceras*, *Glyptoxoceras*, and the new genus, *Smedaliceras.* In younger Campanian strata *Cirroceras* and *Bostrychoceras* have been collected, in addition to the genera described by Stephenson (1941). The incomplete, broken, and corroded steinkerns of the heteromorphs do not yield sufficient data to add any information to the phylogeny and evolution of this group.

Desmocerataceae

Several species of *Parapuzosia,* s. l., and Pachydiscines are known from the Texas Campanian. The parapuzosiines are so large that they defy comparison with the smaller forms that have been illustrated from other parts of the world. Furthermore, the Texas parapuzosiines do not fit the restricted definition given by Wright (Arkell, Kummel, and Wright, 1957) for *Parapuzosia s. s. P. bösei* Scott and Moore in the smallest specimen known to me agrees with Wright's definition, and I am assuming that in their great size the Texas forms have grown beyond the size to which Wright's definition can be applied. Among the pachydiscines, a definite specimen of *Menuites* is known, and some probable juveniles. *Eupachydiscus* is represented in the lower Campanian and latest Santonian by 3 species, and there are 3 different morphotypes of species comparable to *Pachydiscus gollevillensis* (d' Orbigny) in the Upper Campanian. *Muniericeras twiningi,* n. sp., is a rare form in Texas.

Other Ammonoids

Senonian Kossmaticeratidae are unknown in Texas, and the single Senonian *Gaudryceras* is specifically indeterminable. The Placenticeratidae are not numerous in the chalk or chalky marls, but are more abundant in the black shale provinces and some of the more argillaceous strata.

SYSTEMATIC PALEONTOLOGY

Depositories

Most of the fossils described herein are deposited at the University of Texas, distributed among the collections of the Bureau of Economic Geology, the collections of the Department of Geology, and the W. S. Adkins collections. There are discussion and figures of a few specimens at the American Museum of Natural History: these are part of the collections studied by Whitfield (1892) and Hall and Meek (1856). There are also discussion and figures of a few specimens at the United States National Museum. In addition many specimens in accession collections at the United States National Museum are also mentioned. In order to save space the following abbreviations are utilized to designate the different collections.

AMNH—Specimens designated with these letters and a number are at the American Museum of Natural History, New York City, N. Y.

BEG—Specimens designated with these letters and a number are in the collections of the Bureau of Economic Geology, The University of Texas, Austin, Texas.

USNM—Specimens designated with these letters and a number are in the curated collections of the United States National Museum, Washington. D. C.

UT—Specimens designated with these letters and a number are in the Department of Geology, The University of Texas, Austin, Texas.

WSA—Specimens designated with these letters and a number are in the W. S. Adkins collections, The University of Texas, Austin, Texas.

U. S. G. S. Mesozoic locality.—This designation with a number indicates a location from which came a specimen or group of specimens indicated by a single accession number at the United States National Museum, Washington, D. C.

Phylum MOLLUSCA

Class CEPHALOPODA

Order AMMONOIDEA

Suborder LYTOCERATINA Hyatt, 1889

Family TETRAGONITIDAE Hyatt, 1900

Subfamily GAUDRYCERATINAE Spath, 1927

Genus GAUDRYCERAS Grossouvre, 1894

GAUDRYCERAS sp.

Pl. 1, figs. 5, 6, and text fig. 9a

Remarks.—WSA–825 is a poorly preserved steinkern retaining just sufficient ornamentation to be identified as belonging to the genus *Gaudryceras* Grossouvre (1894). Although somewhat crushed, the whorl section seems somewhat higher relatively than does the section of *G. mitis* (Hauer).

Measurements are as follows:

D	U	HF	W	HF/W
WSA–825				
100.0	38.0	42.0	24.0	1.75
50.0	42.0	36.0	21.0	1.62

Horizon and locality.—*Gaudryceras* sp., WSA–825, is from 10 to 11 feet above the *Exogyra tigrina* bed, Burditt marl, about 100 yards above the creek crossing of Turnersville Creek, Travis County. This section was described by Durham (1949). Lower Campanian, zone of *Delawarella delawarensis.*

Superfamily TURRILITACEAE Meek, 1876

Family BACULITIDAE Meek, 1876

Genus BACULITES Lamarck, 1799

BACULITES sp. cfr. B. AQUILAENSIS Reeside, 1927

Pl. 1, figs. 1–4, 9

Remarks.—There is little reason to write a specific description when Reeside (1927a) has done so well on much better material. There is little difference between the Texas forms and Reeside's species, other than size and ribbing. The Texas forms more nearly approach the specimen Reeside (1927a) illustrated on Pl. 8, fig. 1, in size and ribbing. The Texas individuals are slightly distorted and therefore conch sections are difficult to compare.

Since the Texas forms of the species are from near the type locality of *Baculites asperoanceps* Lasswitz (1904), they may belong to Lasswitz's species. If this is true, then *B. aquilaensis* Reeside may be a synonym of *B. asperoanceps* Lasswitz. Lacking casts of the holotype of *B. asperoanceps* for definite comparison, I am withholding a final decision on the synonymy because some of Lasswitz's figures are very accurate and good and others completely distort any concept of the species he intended to illustrate.

Horizons and localities.—UT–964 is from the basal part of formation B, Upper Coniacian, and UT–1365 is basal Dessau, Upper Santonian. The former is from Travis County and the latter from Williamson County, Texas. The forms may not be conspecific, but preservation and meager collections make a more mature study impossible.

BACULITES sp. cfr. B. ANCEPS Lamarck, 1799

Pl. 2, figs. 18, 20–22

Remarks.—The individuals of *Baculites* from the Austin chalk are always poorly preserved. This is probably the reason that they have been reported so seldom —writers have hesitated to identify them because of the poor preservation. The specimens illustrated as *Baculites* sp. cfr. *anceps* Lamarck are no exception, particularly the smaller specimen. The larger individuals agree generally in ribbing, rib-spacing, rib-shape and cross section to Römer's (1852) illustration of his *B. anceps* Lamarck. Little more can be done with these fossils, especially without casts of the type material.

Horizon and locality.—Probably from the upper part of the Dessau chalk or the lower part of the Burditt marl at the old Sprinkle Road crossing of Walnut Creek, Travis County, Texas; Lower Campanian.

Family NOSTOCERATIDAE Hyatt, 1894

The heteromorphs from the Anacacho limestone are not sufficiently well preserved to be easily assigned to genera. Consequently the assignments here made are only tentative.

Genus BOSTRYCHOCERAS Hyatt, 1900

BOSTRYCHOCERAS SECOENSE, n. sp.

Pl. 3, figs. 1–5; pl. 4, figs. 4, 8; text fig. 7s

=*Bostrychoceras* n. sp. aff. *polyplocum* (Romer) in Adkins, 1928, p. 214, pl. 37, figs. 1, 3

=*Bostrychoceras* aff. *polyplocum* in Adkins, 1933, p. 473

Holotype.—WSA–662, from the Anacacho limestone, above D'Hanis on Seco Creek, Medina County, Texas. This is the specimen illustrated by Adkins (1928, pl. 37, figs. 1, 3).

Specific characters.—Oligogyral, turriliticonic in later whorls, with U-shaped body chamber, the U opening toward the spire. Juvenile stage is unknown. WSA–662, the holotype, and UT–30506 each show about three whorls in the cone. Costation is moderately dense, the number of slightly right to left ribs ranging from about 50 on the last whorl of UT–30506 to about 65 on the last whorl of WSA–662. UT–30506 is flattened in the plane of the picture (pl. 4, fig. 4); WSA–662 is relatively undistorted. Every second or third rib bears two low nodes, the upper about the middle of the whorl and the lower about midway between the upper and the subjacent spiral suture, nodes becoming stronger on the body whorl. Aperture and suture are unknown.

Remarks.—*Bostrychoceras secoense*, n. sp., was considered a new but undescribed species by Adkins (1928, p. 214 and pl. 37, figs. 1, 3), but it seems to differ from *B. polyplocum* (Römer) only in the possession of the two rows of nodes. I do not believe that *B. secoense*, n. sp., can be differentiated from the nodate forms described as *B. polyplocum* (Römer) by Schlüter (1872) on his pl. 34, figs. 1 and 3, but it can be differentiated from the non-nodate forms illustrated by him on pl. 33, figs. 3 and 4. Although Schlüter (1872) shows considerable variation from non-nodate to partially nodate (pl. 33, fig. 5) to nodate, all of the individuals from the Anacacho limestone are consistently nodate on the body whorl and on the spire, lacking the variation shown by Schlüter. Some of the softer steinkerns from Texas have most of the nodes effaced by weathering. The group of species within the genus *Bostrychoceras* which are closely related to *B. polyplocum,* need a thorough study to determine the true range of variation. Maybe the entire group should be considered one species. I am keeping the Anacacho forms distinct until an overall re-evaluation can be made; the material from Texas is not sufficiently well preserved or in sufficient quantity to merit any comprehensive studies.

Only two good individuals can be assigned to the species, the holotype, WSA–662, and UT–30506. However, other fragments associated stratigraphically can be assigned to *B. secoense,* n. sp. These include UT–30501, UT–30509, UT–30507, UT–30506, UT–30707, UT–30708, BEG–20368, several specimens in the U. S. National Museum, U. S. G. S. Mesozoic locality 7680, and a dozen or so specimens in the collections of Miss Constance Wollman.

Horizon and localities.—The holotype is from Seco Creek, Medina County, probably from the same locality as UT–30501 and UT–30506—UT–30509. The latter are from the *Echinocorys texana* zone of the Anacacho limestone, several miles above D'Hanis on Seco Creek, Medina County, Texas. Stephenson has also collected this species from Seco Creek. U. S. G. S. Mesozoic locality 7680 is on the left bank of Hondo Creek at King's Water Hole, 3 miles west by north of Hondo, Medina County, bed 2 of Stephenson's unpublished section. UT–30707 and UT–30708 were collected by R. L. Cannon, and are from Hondo Creek, near U. S. G. S. Mesozoic locality 7680.

A similar, but different species is from the Annona chalk, at White Cliff, Arkansas (Adkins collections), and still another similar species occurs in the Austin chalk equivalents (Coniacian) of Trans-Pecos Texas.

BOSTRYCHOCERAS BRAITHWAITEI, n. sp.

Pl. 1, figs. 7, 8, 15; pl. 18, fig. 4

Holotype.—UT–10619, probably from the upper part of formation B, Lower Santonian, Travis County, Texas.

Specific characters.—Conch turriliticonic, sinistral, high spired, with at least three volutions. All individuals are broken at the apertural and apical ends. Whorl section is intermediate between quadrate and circular.

The ornamentation consists of from 15 to 16 ribs per volution, extending from spiral suture to spiral suture, and across the base; weakest on the shoulder; sloping from left to right. Intercostae are about twice as wide as costae. Each rib bears four nodes; the upper node is below the shoulder; the next two nodes are closer together and at the lower curvature; the fourth node is on the umbilical margin, and the lower two nodes are covered by the succeeding whorl, giving the appearance of two nodes low on each whorl. The last whorl, then, is the only whorl to show all four nodes.

Aperture and suture are not known.

Remarks.—*Bostrychoceras braithwaitei,* n. sp., has the general appearance of "*Bostrychoceras*" *subangulatum* (Spath, 1922), except that Spath's species has squarer shoulders and the tubercles are much higher on the whorl. Of course, if aberrant coiling should eventually be discovered at the smaller end, then neither species could be considered assignable to *Bostrychoceras.* The holotype, UT–10619, of *B. braithwaitei* has weaker ribs and sharper tubercles than does the individual collected by Braithwaite (1958), UT–30582; but with only two individuals of comparable size there is certainly no excuse for naming two species at this time, especially when both individuals appear to be Santonian.

A large, crushed, and poorly preserved fossil, UT–966, about three times as large as the holotype of *B. braithwaitei,* has been recovered from the latest Coniacian zone of *Prionocycloceras gabrielense*, n. sp., on the University of Texas campus. This fossil has inconspicuous ribs, and may or may not belong to *B. braithwaitei.*

Horizon and localities.—The holotype of *B. braithwaitei* is from 2 miles southeast of Watters Park on Little Walnut Creek, Travis County, from a fault block, and the formation is indefinite; but the fossil is from the Austin chalk. Another specimen, UT–30582, is from the San Carlos formation, with Santonian fossils, about 6¾ miles southeast of the Colquitt Ranch house, Jeff Davis County (Braithwaite, 1958). Santonian.

Genus CIRROCERAS Conrad, 1868

CIRROCERAS REEVESI, n. sp.

Pl. 5, figs. 2, 3, 6; text figs. 7km

Holotype.—UT–30491, from 100 feet above the *Exogyra laeviuscula* beds, Anacacho limestone, Sabinal River, 5¼ miles north of Sabinal, Medina County, Texas, collected by Frank Welder and Frank Reeves.

Specific characters.—Heteroconic, open helical coil in adult; whorl section circular. Costation is dense, ribs sloping from right to left at a maximum angle of about 30° from vertical. There are about 40 ribs per volution, ribs being simple, continuous, not bifurcating, rounded symmetrically in section. One or two tubercles are present on some ribs, and these are probably forecasting the two rows of nodes on the body chamber of this species. The nodes are low and rounded when not effaced. The ribs are reduced and on some individuals nearly effaced on the inside of the whorls.

Remarks.—The individuals of *Cirroceras reevesi*, n. sp., are eroded and do not have the earliest stage or the body chambers preserved, thus the generic assignment is not entirely satisfactory. However, the general lack of tubercles indicates *Cirroceras* Conrad rather than *Emperoceras* Hyatt, providing the latter genus is valid and not a synonym of *Cirroceras.* The individuals of *C. reevesi* are dextral whereas those illustrated of *C. nebraskense* (Hyatt) are sinistral, but the samples are not large enough to be significant and this difference could be the result of chance collecting. *C. nebraskense* also has a much greater density of costation than does *C. reevesi.* The Upper Cretaceous heteromorphs need monographing, and the present assignment is only tentative. The Texas material is certainly too sparse and too poorly preserved to justify any comprehensive changes in the heteromorph classification. The following individuals can be assigned to *Cirroceras reevesi*, n. sp., at this time: UT–30490, UT–30491, and a fragment from U. S. G. S. Mesozoic locality 16424, in the U. S. National Museum.

Horizon and locality.—UT–30490 is from the same horizon and locality as the holotype.

Family ANISCOCERATIDAE Hyatt, 1900

Genus ALLOCRIOCERAS Spath, 1926

ALLOCRIOCERAS HAZZARDI, n. sp.

Pl. 6, figs. 1, 4–9

=*Crioceras* cf. *latus* Udden, 1907, p. 33

=*Crioceras* n. sp. Adkins, 1928, p. 256; Adkins, 1933, p. 451

="*Crioceras*" Moon, 1953, pp. 158, 159, 161, 162; Lonsdale, Maxwell, Wilson and Hazzard, 1955, pp. 34, 35, 39

Holotype.—BEG–3300, from the Boquillas limestone, 100 ± yards north of no. 16 headshaft of the Chisos Mining Company, section 295, block G-4, Terlingua Special Sheet, Brewster County, Texas; collected by W. S. Adkins and M. B. Arick.

Specific characters.—Heteroconic, coiling in an extremely shallow helicoid spiral, almost in one plane, with earliest ontogeny unknown. The intercostal whorl section is almost as wide as high, and almost circular. The costal section is higher than wide and subtabulate because of the location of the spinose tubercles.

Costation is pronounced and moderately dense; costae wider than intercostae. There are no intercalations or bifurcations and all costae are primary. Usually every third costa is ventrolaterally spinose, but occasionally the second, or even the fourth, bears the spine instead of the third. The spinosity of every third rib seems to be consistent and characteristic of the later ontogeny. Costation increases steadily in strength during the ontogeny, but is nearly effaced on the dorsum at all stages.

There is one row of ventrolateral spines on each side, every third rib being spinose in the adult; occasionally the second or fourth rib bears the spine in younger stages. The spines seem to appear as early as the costae.

All individuals of *Allocrioceras hazzardi*, n. sp., are calcite replacements which have been partially silicified. As a result all of the individuals are preserved by natural solution or etching, and the septa have been destroyed. There is not sufficient silica to allow proper etching with acid. The body chamber and the aperture are unknown.

Remarks.—The absence of the earliest growth stages leaves the generic assignment in some doubt. *Exiteloceras* would be a fine assignment were the coiling more elliptical and the individual a couple of substages younger. *Allocrioceras* appears to be the next best assignment even though evidence "that early whorls are distinctly helical and twisted" [Wright (Arkell, Kummel, and Wright, 1957)] is lacking.

The species is much more spinose than *A. pariense* (White), and has sharper spines and straighter costae than *A. woodsi* Spath. There are many specimens of *A. hazzardi* in the collections, including UT–30686, UT–30684, BEG–20277 (several individuals), UT–30658, the holotype, and others.

Horizon and localities.—The holotype is from the Boquillas limestone, Terlingua area, Brewster County, Texas. In the Agua Fria Quadrangle (Moon, 1953) and the Big Bend National Park (Lonsdale, Maxwell, Wilson, and Hazzard, 1955) *Allocrioceras hazzardi*, n. sp., is from a ledge commonly termed the "*Crioceras*" ledge or "*Crioceras*" zone, which occupies a position in the Boquillas limestone about 150 feet below the base of the Fizzle Flat lentil (Moon, 1953). It is known from east of Dryden, Terrell County, and through much of the Big Bend country of Trans-Pecos Texas. Upper Turonian.

Family PHLYCTICRIOCERATIDAE Spath, 1926

Genus PHLYCTICRIOCERAS Spath, 1926

PHLYCTICRIOCERAS sp. cfr. P. DOUVILLEI Grossouvre, 1894

Pl. 4, figs. 2, 3; pl. 11, fig. 2; text figs. 7fh

Remarks.—Considering that their ages are so near identical and that the fossils are so near identical Renz (1936) was probably correct in placing *Phlycticrioceras oregonense* Reeside (1927c) in synonymy with *P. douvillei* (Grossouvre, 1894). A whorl section of Reeside's specimen, USNM–73267, is reproduced here (text fig. 7f). Whether the individuals discussed and figured by Renz (1936) and the individuals here tabulated from Texas are the same species as Reeside's and Grossouvre's is still in doubt. There seems to be no reason to doubt the Coniacian age of Reeside's or Grossouvre's specimens. The Central Texas specimens occur above the base of the zone of *Texanites texanus gallicus* Collignon, and are younger than the Wyoming or European forms. The exact association of Renz's specimen is not known, and its age relationship cannot be determined. As can be seen the cross sections (text figs. 7fh) are somewhat different between Reeside's individual and the Trans-Pecos Texas individual. The form from Trans-Pecos occurs in the zone of *Stantonoceras guadalupae*, and therefore appears to be not later than Upper Santonian and more likely Lower Campanian, younger than the Central Texas form. An individual, crushed, from the Madiera Spring dam, northeast front of the Davis Mountains (Brundrett, 1955) occurs with *Proplacenticeras* sp. and appears to be associated with upper Coniacian fossils.

Horizon and localities.—UT–10316 is from Madera Spring dam, northeast front of the Davis Mountains, Trans-Pecos Texas; UT–30584 and UT–30499 are from the San Carlos formation, about 6¾ miles southeast of the Colquit Ranch house, Jeff Davis County, Trans-Pecos Texas. They occur with *Stantonoceras guadalupae* (Römer), *Pseudoschloenbachia chispaensis* Adkins, *Placenticeras* sp. juv. cfr. *P. planum* Hyatt, and *Placenticeras planum* transitional to *Stantonoceras sancarlosense* (Hyatt). Another individual from Central Texas is from formation C, zone of *Texanites texanus gallica,* Brushy Creek, Williamson County. According to Renz (1936) his specimen was from just south of the Rio Bravo above Piedras Negras, Coahuila, near Jiménez.

Genus EXITELOCERAS Hyatt, 1894

EXITELOCERAS ? sp.

Pl. 4, fig. 5; pl. 8, fig. 2; pl. 20, fig. 12; text fig. 9e

Remarks.—The fragment from the upper Taylor formation consists of about 110° of a volution. The whorl section (text fig. 9e) is restored and highly interpretive, but the whorl width is slightly more than ½ of the whorl height. The ornamentation is somewhat intermediate between the densicostate widely spaced binodosity of *Neocrioceras* and the less densely costate unituberculate *Exiteloceras.* Occasionally two nontuberculate ribs are adjacent. Presumably the ribs continue across the venter, as interpreted from the crushed individual. Coiling, body chamber, and suture remain unknown.

Horizon and localities.—Of two specimens of *Exiteloceras* ? n. sp., one is from the upper Taylor claystone, from the bank of Brushy Creek, just west of Rice's Crossing, Williamson County. It is Upper Campanian (BEG–317). A similar but distorted individual, UT–1050, is from a chalk in the Taylor claystone (Pecan Gap ?) from an exposure in a hillside near the railroad, one mile towards Round Rock from Taylor, Williamson County. Collector, Young.

Family DIPLOMOCERATIDAE Spath, 1926

Genus GLYPTOXOCERAS Spath, 1925

The specimens here assigned to *Glyptoxoceras* consist of fragments of several individuals. Because of the straight shanks and single, nontuberculate ribs it seems best to assign the species to *Glyptoxoceras* Spath.

GLYPTOXOCERAS ELLISONI, n. sp.

Pl. 1, figs. 10–14, 16–20; pl. 73, fig. 9; pl. 78, fig. 6

Specific characters.—Aberrant, but coiling. Ontogeny is unknown. The several fragmental specimens, which are all included in the species because the rib morphology is constant for all of the fragments, show open coiling or straight shafts. The shell section is usually a slightly distorted circle. No constrictions can be observed on any of the fragments. Costation is moderate, consisting of ribs which become weak on the dorsum, but are always visible on the dorsum except on individuals which are badly corroded or abraded. The ribs are evenly spaced, and steeper apicad than orad. Costae are about the same width as intercostae, and the ribs are slightly prosiradiate.

Remarks.—Except for one specimen all of the individuals of *Glyptoxoceras ellisoni,* n. sp., are much larger than the individuals of *"Helicoceras" rubeyi* Reeside (1927a); consequently comparison is difficult. The Reeside individuals have about the same rib density as the Austin chalk species, and agree with the Austin chalk species in having the steep flank of the rib apicad. *"Helicoceras" rubeyi* Reeside has fuller, higher ribs than *G. ellisoni*; this may result from a combination of better preservation plus retouching of the illustrations of *"H." rubeyi.* The elliptical conch section described by Reeside (1927) does not occur in *G. ellisoni,* but Reeside's specimens may have been distorted by sedimentary load.

Diplomoceras ellipticum (Anderson, 1902) and *D. phoenixense* (Anderson, 1902) are more densicostate, and have many more constrictions than *G. ellisoni,* but *G. ellisoni* is much like *Diplomoceras* sp. aff. *D. recticostatum* (Seunes) in Anderson (1958), except that the latter has sharper, more pointed ribs. *Diplomoceras mercedense* Anderson (1958) is much like *G. ellisoni*, but possesses constrictions.

Horizon and localities.—At least 9 specimens are known at this writing; UT–97, UT–116, WSA–91, UT–182, UT–182B, UT–95, and UT–10856, and specimens from collections from U. S. G. S. Mesozoic localities 7508 and 9702.

This species ranges through the Dessau limestone in Central Texas (Lower Campanian). One specimen is from the *Exogyra tigrina* epibole (top of the Dessau limestone), on Little Walnut Creek, Travis County; BEG locality 226–T–12. Other specimens are from the base of the Dessau limestone on Brushy Creek, Williamson County. In 1911 Stanton and Stephenson collected an individual from the base of the Brownstown or top of the Blossom near Paris, Lamar County (U. S. G. S. Mesozoic locality 7508), and Stephenson in 1916 collected another specimen from 3½ miles southwest of Paris (U. S. G. S. Mesozoic locality 9702). A similar species occurs with *Placenticeras intercalare* at a higher horizon in the Prairie Bluff in the East Gulf Coast.

Genus SMEDALICERAS*, n. gen.

Type species.—*Smedaliceras durhami*, n. sp.

Generic characters.—Heteroconic, probably crioceraconic, but could be a very low helical coil. Only fragments are known, but all fragments have the same arc of coiling. There is no keel, and height is usually greater than width; HF/W ranges from 1.00 to 1.20.

Costation is dense with costae about twice as wide as intercostae. Every fifth to seventh rib bears a large nodate median ventral tubercle, and every fifth to seventh rib bears a bullate lateral tubercle, but the ribs with lateral tubercles may or may not bear the ventral tubercles.

The suture is typically lytoceratan, with reduced elements.

Remarks.—Of Upper Cretaceous heteromorph genera only *Phlycticrioceras* Spath and *Jouaniceras* Basse have median ventral tubercles. *Phlycticrioceras* has median ventral tubercles on each rib, and also has ventrolateral tubercles on each rib. Whether *Smedaliceras*, n. gen., can be related to *Phlycticrioceras* or not is doubtful, but such a relationship is easier to draw than a relationship to genera with ventrolateral tubercles only.

Smedaliceras, since the tubercles are developed only on scattered ribs, is probably developed from some nontuberculate form. The different sizes of the fragments all have about the same degree of coiling; from this it is assumed that the coiling is crioceraconic. The only heteromorph with similar ornamentation is *Jouaniceras* Basse, but no helical coils have been found in association with *Smedaliceras*, n. gen. None the less, *Jouaniceras* is only slightly older, and strictly on ornamentation would seem to be the closest relative, although its ribs are much sharper. *Smedaliceras* is much more densicostate than *Jouaniceras*, has tubercles on fewer ribs, and is an open coil. Whether there is a helical coil in *Smedaliceras* is unknown, but the evidence is all negative.

Horizon and localities.—*Smedaliceras*, n. gen., is from the Lower Campanian, being associated with *Marsupites americanus*, *Parapuzosia bösei* Scott and Moore, *Parapuzosia* sp., "*Ostrea*" *centerensis* Stephenson, *Exogyra laeviuscula* Römer, *E. tigrina* Stephenson, *Terebratulina guadalupae* Römer, *Spondylus guadalupae* Römer, and various texanitids. This association is just below or in the base of the zone of *Delawarella delawarensis*.

SMEDALICERAS DURHAMI, n. sp.

Pl 6, figs. 2, 3, 10–16; text figs. 7a–ep

Holotype.—UT–10860, from the lower stratum of the Burditt marl, Turnersville Creek crossing, Travis County, Texas; Lower Campanian. I collected this specimen from bed *a* of the section illustrated by Durham (1949, pl. 18).

Specific characters.—In addition to the remarks under generic characters, above, the following statements are pertinent. A juvenile heteromorph associated with this

* From a Norwegian surname, "Smedal," in which both syllables are accented equally.

fossil shows no tuberculation and has costation as in *Glyptoxoceras ellisoni*, n. sp. Whether this juvenile belongs to *S. durhami* is not known, but is doubted.

The costation of *S. durhami*, n. sp., is weaker on the dorsum than on the venter, but there is no impressed zone. There are about 5 ribs per centimeter of length, if measurements are made on the flank.

Measurements of several individuals are as follows (figures are in mm.):

	HF	W	HF/W
UT–10857			
	16.5	15.0	1.10
	9.0	8.7	1.05
	8.5	8.0	1.06
UT–10855			
	14.5	13.0	1.12
	11.5	11.0	1.04
UT–10860 (holotype)			
	21.5	19.5	1.10
	20.0	18.5	1.08

Remarks.—Only one species of the genus, *Smedaliceras durhami*, n. sp., is known at the present time. The symmetry of the tubercles on the ribbing, the symmetry of the ribbing, and the symmetry of the tubercles and ribs in relation to the suture, plus the lack of an impressed zone, indicate that the species is an open planispiral coil, whether regular or slightly elliptical cannot be determined. The degree of curvature of the fragments is sufficiently consistent to preclude any great ellipticity. The sutures are positioned in the intercostae.

The individuals known to me include WSA–56, UT–10860, UT–10857, UT–10856, UT–10855, and UT–135.

Horizon and localities.—All of the individuals of *Smedaliceras durhami*, n. sp., known to me are from the lower part of the Burditt marl, Travis and Williamson Counties, Texas. Lower Campanian, zone of *Delawarella delawarensis*. Individuals have been collected at the Turnersville Creek crossing, Travis County, from Little Walnut Creek and Highway 291 (BEG locality 226–T–42), and from a tributary to Brushy Creek, ½ mile on the Williamson County side of the Williamson-Travis county boundary on the Pflugerville-Hutto Road, Williamson County. *Smedaliceras durhami*, n. sp., occurs with *Parapuzosia bösei* Scott and Moore, *P. americana* Scott and Moore, *Eupachydiscus jimenezi* (Renz), *Menabites belli* n. sp., etc.

Superfamily SCAPHITACEAE Meek, 1876

Family SCAPHITIDAE Meek, 1876

Genus SCAPHITES Parkinson, 1811

A discussion of the genus is unwarranted because of the scarcity of the Texas material. Nothing can be added to previous discussions (Reeside, 1927a; Cobban, 1951).

SCAPHITES HIPPOCREPIS CRASSUS Reeside, 1927

Pl. 2, figs. 1–4, 6–13; pl. 10, figs. 1, 5; text fig. 7g

Synonymy.—For early synonymy see Reeside (1927a).

?=*Scaphites hippocrepis* DeKay in Adkins, 1933, p. 458

Remarks.—Reeside's (1927a) description of the species and subspecies is adequate. The Texas material consists of a dozen or so specimens, mostly from the Dessau limestone in the vicinity of Pilot Knob, Travis County. The Texas specimens, at least in the illustrations, appear even more robust than Reeside's (1927a, pl. 17, figs. 6–15); but I had more success comparing them directly with the individuals at the U. S. National Museum than I did with the illustrations. The Texas specimens are more like the one individual illustrated by Weller (1907) with their slightly more pronounced nodes which accent the ventrolateral shoulders. The ribbing and costation duplicate that of Reeside's specimens, except in the flank where the nodes are more pronounced. However, Reeside's figure 14 (Pl. 17, 1927a) of a smaller specimen shows good nodes on the flank. The Texas specimens seem to be within the range of variation of the subspecies, although, if only the nodes were considered, there would be a significant difference between the Rocky Mountain and Texas forms.

Horizon and localities.—All of the

specimens of *Scaphites hippocrepis crassus* Reeside in my possession are from the Dessau limestone in the vicinity of Pilot Knob, Travis County. Very likely collection failure is the reason for lack of specimens from elsewhere, but there may have been some ecologic value to the shallower, often shoaling waters of the Pilot Knob area (Weiss and Clabaugh, 1955). Professor F. L. Whitney and his students collected this locality for many years. Whether or not the individuals reported by Stephenson (1923) belong to Reeside's subspecies is unknown. Lower Campanian.

SCAPHITES sp. cfr. S. AQUISGRANENSIS Schluter, 1872

Pl. 80, figs. 3, 4

Holotype.—The holotype should be the specimen illustrated by Schlüter (1872), if it is still extant.

Remarks.—The specimen from Texas (pl. 80, figs. 3, 4) may be conspecific with the holotype; it is slightly water worn. It has the heavier straight ribs on the flank of the body chamber, with finer ribs on the phragmacone. The ribs on the body chamber terminate in faint clavae on the ventrolateral shoulders and in umbilical nodes. The finer ribs of the phragmacone have long umbilical bullae and no other tuberculation. Conch shape is like that of Schlüter's specimen (1872, pl. 24, figs. 7–9). I cannot agree to assigning this species to *Discoscaphites*. Nowak (1911) only questionably placed it in *Hoploscaphites,* and Frech (1915) classified it in *Discoscaphites.* Reeside (1927a) apparently followed Frech's interpretation.

Horizon and locality.—The lone specimen of *Scaphites* sp. cfr. *aquisgranensis* (Schlüter) is from the Austin. It is from the Austin area, Travis County, and indicates the Lower Campanian.

SCAPHITES sp. cfr. LEEI PARVUS Reeside, 1927

Pl. 20, figs. 5, 6

Holotype.—The specimen illustrated by Reeside (1927a, pl. 21, figs. 8–14).

Remarks.—The single body chamber from the Austin chalk seems to belong to *Scaphites leei parvus* Reeside. The nodes are stronger on the early part of the living chamber than are similar nodes on *S. aquilaensis nanus* Reeside; also the ribs are coarser across the body of the living chamber in the Texas specimen, and in *S. leei parvus,* than they are in *S. aquilaensis nanus.* The Texas specimen is somewhat larger.

Horizon and locality.—Burditt marl, just above the bridge across Little Walnut Creek, Highway 291, Travis County, Texas; Lower Campanian.

Genus ACANTHOSCAPHITES Nowak, 1911

ACANTHOSCAPHITES sp. cfr. A. SPINIGER (Schluter, 1872)

Pl. 4, figs. 1, 6, 7; pl. 5, figs. 1, 4, 5

=*Scaphites spiniger* Schlüter, 1872, pl. 25, figs. 1–6

Remarks.—The material from Texas does not warrant an attempt at specific description, especially without comparable topotype individuals. Several individuals of scaphitines occur in the Anacacho collections. These are usually corroded, and nearly without costation. However, close scrutiny reveals a few ribs in areas sheltered from corrosion, indicating that the costation has been effaced. These forms compare favorably with Schlüter's (1872) "*Scaphites*" *spiniger,* except that the tubercles are not as clavate on the Texas forms. The Texas individuals also range extremely in degree of compression, but this range either results from or is enhanced by sedimentary processes rather than from original organic variation, and the greater the individual has been compressed by sedimentary processes, the more elongate the clavae. All tubercles are distinctly clavate. Whether the considerable clavateness of tubercles on Schlüter's specimens is partly a result of sedimentary processes cannot be determined from his drawings.

Examination of *Scaphites porchi* (Adkins, 1929, pl. 5, figs. 1–3) shows no costation on the aperturad part of the body whorl. Individuals of this species from the type locality and now in the University of

Texas collections also show no costation on the aperturad part of the body whorl. These are fresh, uncorroded steinkerns, and the absence of costation seems to be an original feature of the specimens. It is doubtful if Adkins' *Scaphites porchi* is conspecific with the Anacacho or German forms, but the Anacacho forms and the German forms may be conspecific. I suspect that *Scaphites aricki* (Adkins, 1929, pl. 5, figs. 7, 8) is the earlier whorls of his *Scaphites porchi.* These earlier whorls do show a peculiar costation not uncommon in different groups of ammonites, and very similar to the costation of "*Scaphites*" *spiniger* Schlüter, but the Pecan Gap chalk forms of Adkins have only nodate tubercles, not the clavae of the German and Anacacho individuals. If the body chamber can range from smooth to costate and if the tuberculation can range from nodate to strongly clavate, then all of these individuals may be conspecific. However, none of the samples are sufficiently large to determine if discontinuities exist between them.

The following individuals are here assigned to *Acanthoscaphites* sp. cfr. *spiniger* (Schlüter): UT–19878, UT–19879, UT–19876, UT–19881, UT–19877, BEG–20403, and UT–30507.

Horizon and localities.—*Acanthoscaphites* sp. cfr. *spiniger* (Schlüter) is from the Campanian. UT–30507 is from the *Echinocorys texana* (Cragin) zone on Seco Creek, north of D'Hanis, Medina County, from the Anacacho limestone. R. L. Cannon has collected several specimens, including UT–19876, UT–19879, and UT–19881, from King's Water Hole on Hondo Creek above Hondo, Medina County. *Echinocorys texanus* (Cragin) also occurs in the Pecan Gap chalk in Travis County with *Scaphites porchi* and *S. aricki* Adkins.

Suborder AMMONITINA Hyatt, 1889

Superfamily DESMOCERATACEAE Zittel, 1895

Family DESMOCERATIDAE Zittel, 1895

Subfamily PUZOSIINAE Spath, 1922

Genus PARAPUZOSIA Nowak, 1913

Remarks.—Not all of the Texas species described under *Parapuzosia* Nowak can be included in that genus if the definition of Wright (Arkell, Kummel, and Wright, 1957) is followed. The large Texas species lose one or both grades of costation at diameters of 300 mm. and more. Species like *Parapuzosia* sp. aff. *P. bradyi* Miller and Youngquist retain a reduced but simpler costation. *P. bösei* Scott and Moore becomes smooth at greater diameters, whereas an as yet undescribed species first loses the coarse costation and then loses all costation at even larger diameters. Of course Wright (Kummel, Arkell, and Wright, 1957) was not considering such large species in his designation. I see no reason for describing a new genus for these three different ontogenies within four species, but am expanding *Parapuzosia* to include them.

PARAPUZOSIA BOSEI Scott and Moore, 1928

Pl. 7, fig. 1; pl 8, figs. 1, 3, 4; pl. 9, fig. 2; pl. 19, fig. 1; text figs. 7jqr

=*Parapuzosia bösei* Scott and Moore, 1928, p. 274, pl. 36, figs. 1–3; pl. 37, fig. 2; Adkins, 1933, p. 453

=*Parapuzosia* sp. (*pro parte*) Adkins, 1933, pp. 450, 451

=*Parapuzosia corbarica* Renz, 1936, pl. 4, figs 1, 1a, 2, 2a; Young and Marks, 1952, fig. 2, p. 484, 486 [not *P. corbarica* (Grossouvre, 1894)]

Holotype.—Scott and Moore (1928) did not designate a holotype, although they state that the type specimens are at Texas Christian University. I hereby designate the individual illustrated by Scott and Moore on pl. 36, fig. 1, as the holotype. It is from Tequesquite Creek, Kinney County, Texas.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, moderately subangustumbilicate, rounded venter. The whorl section is higher than wide, HF/W equalling about 1.5 in the younger whorls, not increasing, if anything decreasing with age. The greatest width is usually near mid flank.

The ornamentation consists of two ranks of costation on diameters preceding 250 or 300 mm. The coarse costae mentioned by Scott and Moore (1928) extend to the umbilicus. On the outer flank and crossing the venter are finer costae also. On the venter there are from 5 to 15 smaller costae between every two larger costae, the larger costae being closer together at the 200 mm. diameter than at the 100 mm. diameter. The large costae extend across the venter as more prominent costae and can be differentiated from the smaller costae on the venter. All costae are symmetrically rounded, flexuous, and projected onto the venter. The large costae on the flanks are wide, flat-topped, and extend to the umbilical wall. The coarse costae are not discernible in Scott and Moore's illustration (1928, pl. 36, fig. 1), but the coarse costae are mentioned by them. On pl. 7, fig. 1, of this work the coarse costae are overly prominent because of the accentuation during the compaction by sedimentary load. Fundamentally there are no true umbilical bullae on this species unless each entire large rib is considered a bulla.

Beyond the 300 mm. diameter the internal mold either becomes smooth or the costae are not preserved on the steinkerns at my disposal, resulting in the large smooth individuals of this species, such as the holotype. Since the smaller costae do not extend dorsad of mid flank they are never visible on the inner whorls of the larger individuals unless the individuals are broken apart.

The largest individual known to me is over three feet (nearly 1 meter) in diameter, and is completely septate. This means that the complete conch was over 5 feet (1.6 meters) in diameter. Even with such large individuals we still have no information concerning the body chamber and the aperture. Part of the suture has been illustrated by Scott and Moore (1928).

Measurements follow, all on young whorls.

D	U	HF	W	HF/W	P	S	B	T
Individual illustrated by Renz (1936, pl. 4, figs. 2, 2a)								
195.0	29.0	41.5	28.5	1.46	14	129±		143±
150.0	29.0	42.5						
100.0	29.0	42.5	28.5	1.49				
Individual illustrated by Renz (1936, pl. 4, figs. 1, 1a)								
180.0	26.5	43.0	30.0	1.43	14	126±		140±
150.0	26.0	44.0						
100.0	29.0	45.0						
75.0	28.5	49.5	34.0	1.45				
UT–1952								
220.0	28.0	42.0	26.0*	1.61				
WSA–277								
156.0	27.0	41.0	27.5	1.49				
100.0	25.0	44.5	30.0	1.48				
75.0		45.5	28.0	1.59				
WSA–286								
150.0	24.5	51.5						
125.0	22.5	50.0						
90.0	21.5	39.0?						
BEG–2307								
106.0	29.5	44.5	29.5	1.51				
75.0	32.0	45.0	32.0	1.40				
60.0	28.5	40.0	27.5	1.45				

The measurement above marked with an asterisk is probably erroneous because of distortion of the steinkern.

I had always been puzzled why there were no constrictions described on representatives of the genus *Parapuzosia* from the Gulf Coast of Texas. One specimen, BEG–2307, has answered this question: the last good constrictions occur at approximately the diameters of 70, 76, and 83 mm. Two very faint constrictions occur beyond this, the last about a diameter of 105 mm. There are about 7 constrictions on the whorl ending at about 85 mm. The absence of the constrictions on the Gulf Coast *Parapuzosia* was because no individual of small enough size had been described to show the constrictions. Furthermore, all ornamentation on the inner whorls tends to be reduced when these whorls are compacted by overlying whorls, probably at the time the aragonite shell dissolved and the steinkern was still soft.

Remarks.—Parapuzosia bösei Scott and Moore has young whorls almost identical to those of *P. corbarica* (Grossouvre). The misidentification of the young of this species for *P. corbarica* has caused considerable confusion. Several remarks made by

Professor Matsumoto during his visit to Austin made me suspicious of the zonation of the Austin chalk and its correlation to other continents. Later, when I had an opportunity to study some of the Santonian and Campanian texanitines, I became convinced that a reanalysis of the Texas *P.* "*corbarica*" was necessary. It was only then that I discovered that a large *Parapuzosia bösei,* which had been broken while prying it out of the Burditt marl with a crowbar, contained *corbarica*-like inner whorls. A restudy of the *P.* "*corbarica,*" UT–1952, of Young and Marks (1952) and Renz (1936) then showed that the Texas forms, the younger whorls of *P. bösei,* had the coarse or large ribs diminished but still persistent and differentiated across the venter (Renz, 1936, pl. 4, figs. 2a and 1); this is not true of *P. corbarica* (Grossouvre, 1894, pl. 27, fig. 1b). Furthermore, *P. corbarica* Grossouvre possesses acute umbilical bullae developing into a single normal costa over the venter whereas *P.* "*corbarica*" Renz (=*P. bösei* Scott and Moore) has flat ribs at the umbilicus which split off small costae ventrolaterally, but remain larger over the venter than do the smaller costae. *P. bösei* Scott and Moore differs from an older, undescribed species in the possession of two grades of ribbing well beyond the 100 mm. diameter, and from *P. americana* Scott and Moore in its more rounded and less acute whorl section, in addition to the probable differences in suture which Scott and Moore (1928) emphasize. The following individuals can at least be assigned to this species: UT–1952, BEG–2307, UT–122, UT-30456, BEG–20342, UT–1982, WSA–277, WSA–286, and questionably BEG–20311 and BEG–20426. There are also the specimens at Texas Christian University. In addition many other large individuals (too large to deposit in collections in great numbers) occupying the same horizon throughout Texas belong to this species.

Horizon and localities.—Parapuzosia bösei Scott and Moore is Lower Campanian instead of the Santonian stated by Scott and Moore (1928). This error is the result of (1) the misidentification of the young of *P. bösei* as *P. corbarica* Grossouvre, and (2) the supposition that *Texasia dentatocarinata* (Römer) was the age equivalent of *Barroisiceras haberfellneri* (von Hauer), which it is not. *Texasia dentatocarinata* is Upper Santonian in age and probably extends into the Lower Campanian with *Bevahites bevahensis* Collignon, if the latter species reaches the Lower Campanian. It was further believed that *Texanites texanus* (Römer) was younger than *Texasia dentatocarinata.* This also seems to have resulted from an erroneous prejudice inherited from false phylogenetic assumptions established outside of North America and into which North American species were arbitrarily fitted. Of course the early North American describers were not accurate in the locality and horizon identification.

Parapuzosia bösei Scott and Moore is of Lower Campanian age, and is associated with various species of *Australiella, Menabites, Delawarella, Neancyloceras, Eupachydiscus,* etc. *P. bösei* is known from the Burditt marl of Travis and Williamson Counties, the "upper Austin" chalk of the Dallas area, the Anacacho Mountain area, and from Tequesquite Creek, Kinney County, Texas.

PARAPUZOSIA sp. aff. P. BRADYI Miller and Youngquist, 1946

Pl. 7, figs. 2, 3; pl. 9, figs. 1, 3, 4;
pl. 11, fig. 1; text fig. 8d

Holotype.—Designated by Miller and Youngquist (1946), and illustrated by them; from the Eagle sandstone, south central Montana; Lower Campanian.

Remarks.—There are five individual fossils from Texas which may or may not belong to *Parapuzosia bradyi* Miller and Youngquist (1946). The individual illustrated on pls. 7 and 9 (UT–30573) is similar to *P. bradyi* in whorl section and ornamentation, even to the disappearance of the ribs ventrolaterally and ventrally. It differs from the Montana form in the greater sinuosity of the flank ribs and in the presence of a fine costation in the young whorls, whorls of a younger ontogeny than illustrated by Miller and Youngquist. Two individuals from the Anacacho Mountain area (BEG–20331 and –20342) and one in the U. S. National Museum (U. S. G. S. Mesozoic locality 7527) are really too badly preserved to identify accurately, but in whorl section and ribbing could belong to the Miller and Youngquist species.

Parapuzosia americana Scott and Moore (1928, pl. 37, fig. 1) also shows short flexuous ribs on the flanks of the individual illustrated by Scott and Moore. It will take much further study to determine the relationships of *Parapuzosia americana* and *Parapuzosia bradyi*, but they seem to occupy about the same part of the Lower Campanian section.

Locality and horizons.—*Parapuzosia* sp. aff. *P. bradyi* Miller and Youngquist appears to be Lower Campanian. UT–1521 is known only to be from the Austin chalk, Central Texas, but the lithology is Dessau limestone. UT–30573 is from about 9 miles southeast of the Colquitt Ranch house and about ¾ mi. from the abandoned railroad, 30°34′20″ N and 104°45′05″ W, Jeff Davis County, Trans-Pecos Texas.

PARAPUZOSIA TERRYI, n. sp.

Pl. 10, figs. 2–4

Holotype.—UT–30475, from a clay member from 100 to 150 feet above the Gober chalk, North Sulphur Creek, Lamar County, Texas.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, widely angustumbilicate to narrowly subangustumbilicate. The venter is rounded and the whorl section is higher than wide (HF/W is 1.5±) and an elongate oval in shape.

Ornamentation consists only of umbilical nodes situated just ventrad of the umbilical wall and short, indistinct, prosiradiate ribs extending from the umbilical nodes for about the first ⅕ of the flank and then disappearing.

This individual, which is a little more than 450 mm. in diameter, is septate throughout, and the only individual of its kind so far recorded from Texas. The aperture and body chamber are unknown. The suture is typical of the genus. Overlap is to about the end of the first ⅓ of the flank.

Measurements are as follows:

D	U	HF	W	HF/W
UT–30475 (holotype)				
450.0	21.0	46.0	31.0	1.48
350.0	14.0?	51.0		

Remarks.—The umbilituberculate individual here named *Parapuzosia terryi*, n. sp., seems to be unique; at least I have been unable to find anything that compares favorably with it. If the younger stages, not observable, are not costate on the venter it will be difficult to retain the species in the genus *Parapuzosia*, s. l. The fossil is preserved in marl and the unevenness of the flanks in the illustration is not ornamentation, but the result of sedimentary compaction. Likewise the venter has been crushed, and the whorl section could not be accurately reproduced.

Locality and horizon.—Same as for the holotype, which is the only individual.

PARAPUZOSIA PAULSONI, n. sp.

Pl. 11, figs. 3, 4, 5; pl. 12, figs. 1–4; pl. 15, fig. 10; pl. 17, fig. 9; pl. 19, figs. 3, 4; text figs. 8ab, 9gjr

Holotype.—UT–30625, from the Gober chalk, near Al's place, McCurtain County, Oklahoma. It was collected by R. T. Hazzard.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, narrowly subangustumbilicate, rounded venter. The whorl section is higher than wide, HF/W ranging from 1.1 to 1.3. At the 50 mm. diameter the greatest width is at the umbilical tubercle, migrating to just dorsad of mid flank at the 90 mm. diameter.

Costation consists of sparse, low, symmetrical in section, prosiradiate costae which continue over the venter but are not as strong on the venter as laterally. The costae are of several grades of length, intercalating sufficiently often to maintain the uneven and sparse costation. Intercostae are from one to four times as wide as the costae.

The tuberculation consists only of low, long umbilical bullae on those costae which reach the umbilicus, about 10 or 11 per volution. By intercalation there are about twice as many costae on the venter as on the umbilicus.

All individuals are septate throughout. The suture is not typically parapuzosiine, the first lateral lobe is almost bifid by the asymmetrical development of the auxiliary elements. The auxiliary lobes of the external lobe are peculiarly long and devoid of numerous frills.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT-19817B								
100.0	19.5	48.5	38.0	1.28	11	9		20
75.0	18.0	51.5						
50.0	23.0	56.0	48.0	1.17				
UT-30662								
115.0	17.5	46.0	37.5	1.23				
82.0	22.5	53.0	44.0	1.21				
30.0	23.5	43.5	31.5	1.37				
UT-30625 (holotype)								
190.0	20.0	51.0	37.5	1.35	20	36		56
150.0	20.5	52.5	42.5	1.24	20			
100.0	23.0	53.0	46.5	1.14	16±			
83 0	24.0	53.0	47.5	1.11				

Remarks.—*Parapuzosia paulsoni,* n. sp., can be assigned to *Parapuzosia* without difficulty, but the strongly prosiradiate, straight ribs are not common to species of this genus. Also the ribs of *P. paulsoni* are just barely projected onto the venter. *P. paulsoni* does not compare closely to any species of *Parapuzosia* known to me and has superficial resemblances to *Kitchenites* and *Neopuzosia.* The absence of constrictions in most of the species of *Parapuzosia* in Texas is puzzling, but may be attributed to the collection and description of only large individuals.

Horizon and localities.—*Parapuzosia paulsoni,* n. sp., has been collected from strata which are thought to be equivalent to the Gober chalk, occurring with *Delawarella delawarense* (Morton) and *D. danei* Young. It is from sec. 28, T. 9 S., R. 27 E., 1 mile west of the Oklahoma-Arkansas state line on the highway from Foreman, Little River County, Arkansas, to Tom, McCurtain County, Oklahoma. Specimens have been collected by both Oscar Paulson and R. T. Hazzard. Miss Constance Wollman has one specimen from about the middle of the Dessau limestone on Williamson Creek, Travis County, where it occurs (in the same bed) with *Placenticeras guadalupae* (Römer), *Submortoniceras tequesquitense,* n. sp., and *Australiella pattoni,* n. sp. The species is Lower Campanian, but the Travis County occurrence is in the zone of *Submortoniceras tequesquitense* whereas the Oklahoma occurrence is in the next higher zone of *Delawaı ella delawarensis.*

Family PACHYDISCIDAE Spath, 1922

Remarks.—The pachydiscines of the Senonian of Texas are extremely poorly preserved. Most of them are internal molds from chalky and marly limestones; usually they are badly corroded and abraded. Because of the state of preservation and rarity of occurrence, the Texas pachydiscines do not warrant any revision or even discussion of revisions of genera.

In assigning various species to genera I have followed the assignations made by Collignon (1955) for those species which he assigned, without regard as to whether I believe such assignation warranted or not. Most of the Texas individuals do not show a sufficient range of ontogeny to make a definite assignment. Others are badly eroded, and Collignon (1955, p. 19) doubts the general utility of pachydiscines for biostratigraphic correlations. On p. 17 (1955) he points out the extreme difficulty of assigning an internal mold to a species originally described on a cast, and vice versa. Consequently, facing all of these difficulties, plus the poor preservation of the Texas forms, I think that age relationships should not be drawn hastily from any pachydiscine information taken from this work.

Genus NOWAKITES Spath, 1922

NOWAKITES (?) sp. cfr. N. (?) FLACCIDICOSTUS (Romer, 1852)

Pl. 16, figs. 5, 6; pl. 76, fig. 5; text fig. 10b

Remarks.—Oligogyral, subgradumbilicate, subangustumbilicate, U decreasing from 31.0 at the 60 mm. diameter to 25.0 or so at greater diameters. The venter is rounded; the whorl section is oval with the greatest width at about mid flank.

The costation is largely destroyed, but consists of umbilicibullate primary ribs plus other ribs intercalating dorsad of mid flank. The costae pass over the venter, but are interrupted over the siphuncle. There are about 13 umbilical bullae, and 29 or 30 ventral costae on the outer whorl. The costae are low, rounded, broad, rectiradiate to slightly prosiradiate. The individual is septate throughout.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
Romer's 1852, pl. 1, figs. 1ab								
88.0	24.0	45.0	37.0	1.34	27	15		42
75.0	25.5	47.5						
60 0	27.5	46.0						
55.0	28.0	46.5	39.0	1.19				
50.0	29.0	41.0						
40.0	31.5	40.0						
UT–19805								
123.0	25.5	46.0	36.5	1.25				
100.0	26 0	46 0	41.5	1.11				
75.0	27.5	46.0	44.5	1.03				
60.0	31.0	44.0	44.0	1.00				

If Römer's (1852, pl. 1, figs. 1ab) illustrations of "*Ammonites*" *flaccidicosta* are as poor as his illustration of *Texanites texanus* and *Texasia dentatocarinata*, the form described here, UT–19805, could belong to it. However, Römer's illustrations show a fossil of the same conch-shape as mine, but with strongly projected ribs (the artist did not or could not show this projection in ventral view), interrupted on the venter as in the form illustrated in the present work.

Collignon (1955) calls Römer's individual badly preserved, and states that it cannot be classified. Presumably he has seen the type, as the restored picture of Römer shows nothing of such poor preservation. Adkins (1933) considered Römer's *Ammonites flaccidicosta* a *Nowakites*, and not having seen the original or a cast I am following Adkins. It is strange so few individuals of this species have reached collections, because Böse and Cavins (1928), Burckhardt (1930), and Muir (1936) all indicate abundant occurrence, unless these writers have misidentified *Eupachydiscus jimenezi* (Renz) for Römer's species.

Horizon and locality.—UT–19805 is from the Austin chalk, but there is no other information on this fossil.

Genus PACHYDISCUS Zittel, 1884

PACHYDISCUS (?) n. sp.

Pl. 13, figs. 3, 4; text fig. 7t

Special characters.—Oligogyral, concentrumbilicate, subgradumbilicate, moderately subangustumbilicate. The whorl section is higher than wide, HF/W ranging from 1.2 to 1.3. The greatest width costally and intercostally is at the umbilical tubercle, the whorl section being suboval, with the flanks converging ventrad.

The individual is too badly eroded to determine if low costae on the flanks connect the umbilical bullae to the low costae which cross the venter. There are about 12 umbilical bullae per volution and probably twice as many costae, low, rounded, and symmetrical, crossing the venter.

The individual is septate throughout.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–19806								
120.0	26.5	43.5	34 0	1.27	12	?	?	?
100.0	26.5	43.5	34.0	1.28				
75.0	23.5	48.0	40.0	1.20				

Remarks.—If Collignon (1955) is correct that an internal mold cannot be assigned to a species based on individuals with the shell preserved, because the specific features are present only on the shell, then it would be impossible to describe but one species of pachydiscines from the limestone and marl formations of the Texas Senonian, because on only one individual in the Bureau of Economic Geology and Department of Geology collections is the shell replaced and its features preserved.

Pachydiscus (?) n. sp. possesses the ornamentation of the species of the genus which are described next, but the whorl section is not nearly so high. It is, then, ornamented as *Pachydiscus neubergicus* (von Hauer) in Grossouvre (1894, pl. 30, figs. 4ab), but with much less compressed whorls.

Horizon and locality.—*Pachydiscus* (?) n. sp. is from the Anacacho limestone. UT–19806 was collected from 9 miles above Castroville, Medina County. Collected by J. A. Taff, 9 July, 1891. During the past 70 years a similar fossil has not appeared.

PACHYDISCUS sp. no. 1 cfr. P. GOLLEVILLENSIS (d'Orbigny)

Pl. 8, fig. 5; pl. 17, fig. 5; text figs. 10co

Remarks.—UT–30516 is a fragment of an individual with the last septum and about 1 cm. each of phragmacone and body chamber. The whorl section is high with rounded venter and subgradumbilicate umbilical shoulders. The costae extend from the ventrolateral regions almost to mid venter; at mid venter they are broken over the siphuncle. One of every three or so ribs reaches the umbilicus, and probably terminates in a bulla, but this part of the steinkern is broken away. UT–30516 has more the appearance of *P. gollevillensis* Grossouvre (1894), pl. 31, figs. 9ab, and pl. 29, figs. 4ab) than it does the appearance of *P. gollevillensis* in Kossmat (1895, pl. 15, figs. 1abc). Kossmat's figure is the one reproduced for Wright (Arkell, Kummel, and Wright, 1957, fig. 494–3ab). The suture of UT–30516 is almost identical to that of the specimen illustrated by Grossouvre (1894, pl. 31, figs. 9ab), even to the secondary frills on the first lateral saddle and first lateral lobe. Costation of these two individuals is almost identical, but UT–30516 has the narrower whorl section of Grossouvre's (1894) pl. 29, figs. 4ab or his (1908) pl. 9, figs. 2ab.

UT–30516 has a narrower, higher whorl section than such similarly ribbed species as *Pachydiscus fresvillensis* (Seunes), *P. summeri* (Maury), and *P. sharpei* Spath. The latter species also lacks umbilical tubercles. *P. papuanus* Böhm has a whorl section which starts to narrow toward the venter at about mid flank instead of at a ventrolateral position.

Horizon and locality.—The specimen of *Pachydiscus* sp. no. 1 cfr. *P. gollevillensis* (d'Orbingy) is from the *Nostoceras* zone, at Rice's Crossing of Brushy Creek, Williamson County, Texas. Upper Campanian, with *Manambolites ricensis*, n. sp., *Placenticeras intercalare* (Meek), etc.

PACHYDISCUS sp. no. 2 cfr. P. GOLLEVILLENSIS (d'Orbigny)

Pl. 13, figs. 1, 2, 5; pl. 14, fig. 4; pl. 17, figs. 1, 8; text figs. 10dg

Remarks.—Several individuals from the upper Anacacho limestone on Hondo Creek, from near King's Water Hole, Medina County, Texas, were collected by R. L. Cannon about 1922. These are mostly incomplete internal molds, preserved in a chalky matrix. Some are distorted, others probably not distorted. No sutures can be observed. These Anacacho limestone individuals possess a high and narrow whorl section, with rounded venter and nearly gradumbilicate umbilicus with flat, parallel flanks. The costae extend across the venter and are seldom broken at mid venter. There are slightly more than 40 ventral costae at a diameter of 80 mm., and about 10 or 11 umbilical bullae. The flanks are devoid of ornamentation.

The Hondo Creek individuals, best illustrated by UT–19869 (pl. 13, figs. 1, 2) are similar to *Pachydiscus* sp. no. 1 cfr. *gollevillensis* (d'Orbigny) of this work and to Grossouvre's (1894) pl. 29, figs. 4ab, in whorl section, but in costation are more reminiscent of Kossmat's (1895) pl. 15, figs. 1abc, which is reproduced by Wright (Arkell, Kummel, and Wright, 1957, figs. 494–3ab) as an example of the genus. The flanks of the individual of Kossmat's illustration converge slightly more toward the venter than do the flanks of *P.* sp. no. 2 cfr. *gollevillensis*. *P.* cfr. *gollevillensis* sp. no. 2, like sp. no. 1, has narrower whorl sections than the similarly ribbed *P. sharpei* Spath (without umbilical bullae), *P. fresvillensis* (Seunes), and *P. summeri* (Maury). *P. papuanus* (Böhm) has the flanks narrowing too rapidly from a position as dorsad as mid flank.

Measurements are as follows:

D	U	HF	W	HF/W
UT–19869				
80.0	24.0	46.5	29.5	1.57
60 0	23.5	47.5	28.5	1.67
UT–19870				
75.0	20.0	49.5	29 0	1.70
50.0	17.0	47.0	33.0	1.42
UT–30503				
73.0	24.5	48.0	33.0	1.45
50.0	25.0	50.0	37.0	1.35
40.0	24.0	49.0	40.0	1.22

In addition to the above individuals there is another specimen, which probably belongs to this species, in a collection in the U. S. National Museum, from U. S. G. S. Mesozoic locality 7680, left bank of Hondo Creek, King's Water Hole, 3 mi. N. of Hondo, Medina Co.

Horizon and locality.—From the Anacacho limestone, Hondo Creek, near King's Water Hole, Medina County, Texas.

PACHYDISCUS sp. no. 3 cfr. P. GOLLEVILLENSIS (d'Orbigny)

Pl. 14, figs. 2, 3; text figs. 7n, 8h

Remarks.—An individual from the *Echinocorys texanus* zone, WSA–288, is from the Anacacho limestone. I am not certain that it can be distinguished from *Pachydiscus* sp. no. 1 cfr. *gollevillensis* (d'Orbigny), but it is from an older horizon and has rectiradiate ribs instead of prosiradiate ribs at the same diameters. Furthermore the siphonal lobe of the suture is longer in sp. no. 3 than in sp. no. 1, with a much deeper superimposed ventral saddle.

Measurements of WSA–288:

D	U	HF	W	HF/W	P	S	B	T
120 0	31 0	40.0	25 0	1.60	21	29±		50±
100.0	32.0	41.0	26.0	1.58				
75.0	31.5	44.5	28.0	1.59				

WSA–288 differs from *P.* sp. no. 2 cfr. *gollevillensis* in its rectiradiate ribs and in the continuation of every second to fourth rib across the flank, and the ribs are concave forward, swinging orad on the venter, and continually crossing the venter without the siphonal interruption so characteristic of species 1 and 2.

Horizon and locality.—WSA–288 is from the *Echinocorys texanus* zone of the Anacacho limestone on the Rothe Ranch, Medina County, about 3 miles above D'Hanis on Seco Creek.

Genus MENUITES Spath, 1922

MENUITES STEPHENSONI, n. sp.

Pl. 15, figs. 1, 2; text figs. 7o, 9n

=*Menuites stephensoni, nomen nudum,* Adkins, 1933, p. 407, 473–475

=*Menuites* n. sp. in Adkins, 1933, p. 467

Holotype.—WSA–69, from the upper Taylor, 40 to 60 feet below the top of the Taylor in the calcareous concretion horizon near Kimbro, Travis County, Texas; Upper Campanian.

Specific characters.—Oligogyral, concentrumbilicate, except for slightly scaphitoid body chamber, craterumbilicate, narrowly to moderately subangustumbilicate. The whorl section is wider than high, HF/W becoming smaller with increase in diameter. The greatest intercostal width is just ventrad of the umbilical wall, near the umbilical bulla, and the greatest costal width is at the umbilical bulla.

Only the outer whorl is well preserved, and on this whorl there are about 14 primary costae, with about 4 intercalating costae. The intercostae are from 2 to 4 times as wide as the costae. Tuberculation consists of nodes on each side of the broad venter and umbilical bullae. The costae are joined across the venter, but are much weaker on the venter than on the flanks. The secondary costae start about mid flank and do not bear umbilical bullae, but terminate with ventral nodes. Primary costae bear both umbilical bullae and ventral nodes. The holotype and only known specimen has a diameter of 111 mm. Septation ceases at the 69 mm. diameter. The body chamber occupies 195°. The aperture may be slightly restricted but is without frills.

The suture is typically pachydiscine, with moderately shallow ventral lobe and moderately digitate lobes and saddles. The apical edges of the saddles form a relatively straight line, and the first lateral lobe extends farther apicad than the ventral lobe. The two secondary elements of the ventral lobe are bifid; the first lateral lobe is trifid. The ventral nodes are positioned in the first lateral saddles, and the umbilical bullae occupy positions between but roughly as long as the suspensive lobes of the sutures.

Measurements of WSA–69 are as follows:

D	U	HF	W	HF/W	P	S	B	T
100.0	27.0	45.0	54.5	0.83	14	4		18
75.0	22.0	47.0	55.0	0.86				
50.0		50.0	55.0	0.91				

Remarks.—Menuites stephensoni, n. sp., differs from *M. menu* (Forbes) and other species of *Menuites* because it has coarser ribs which persist on the body whorl to the aperture. The aperture of *M. stephensoni* is less restricted than is the aperture of *M. menu*. *Menuites* sp. juv. indet. is known only from juveniles, but occurs in the lowermost Upper Campanian, zone of *Hoplitoplacenticeras vari*, whereas *M. stephensoni* is from the uppermost Upper Campanian.

Horizon and locality.—Same as for the holotype.

MENUITES sp. juv. indet.

Pl. 15, figs. 6, 7, 9, 11, 12; pl. 20, figs. 10, 11; text fig. 9q

Specific characters.—Oligogyral, concentrumbilicate, craterumbilicate, subangustumbilicate. The whorl height is about the same as the whorl width, so that HF/W ranges only little from unity. The greatest intercostal width is just dorsad of mid flank and the greatest costal width is at the umbilical tubercle. Costation is reduced on these small molds, with long umbilical bullae and shorter ventral bullae. The costae almost efface on the shoulders and disappear completely on the venter. There are about 15 umbilical tubercles per whorl at the 30 mm. diameter. The apertures are unknown and the sutures are too poorly preserved for duplication.

Measurements are as follows. Figures with an asterisk are in mm.

D	U	HF	W	HF/W	P	S	B	T
WSA–63								
30.0	26.5	47.0	48.5	0.93	13	8±		21±
20.0	27.5	47.5	50.0	0.95				
WSA–60								
		13.5*	13.5*	1.00				
WSA–61								
		16.5*	16.0*	1.03				
WSA–62								
		11.5*	12.0*	0.96				
WSA–57								
47.5	23.0	50.5	48.5	1.03				
30.0	23.5	46.5	45.0	1.03				

Measurements of the following specimens are of *"Anapachydiscus" complexus* (Hall and Meek, 1856) for purposes of comparison:

small specimen					
16.0	25.0	43.5	66.5	0.65	11 bullae, disappearing ventrally
8.0	22.0	56.5	84.5	0.67	
large, figured specimen					
21.0	21.5	44.0	68.0	0.65	
large, unfigured					
		19.5*	25.0*	0.78	
28.0	21.0	48.0	66.0	0.73	8 bullae
17.0	20.5	56.0	81.0	0.69	

Remarks.—Menuites sp. juv. indet. cannot be placed nomenclatorially or taxonomically at this time; larger, more adult individuals are needed. The ventral bullae are unusual, and a height-width ratio at near unity is not typical of species of *Menuites*. The ventral tubercles of *M. stephensoni*, n. sp., and *Menuites* sp. juv. indet. are positioned higher on the venter than are those of *M. menu* (Forbes). *Menuites* sp. juv. indet. differs from *"Anapachydiscus" complexus* (Hall and Meek) in the juveniles in the much more tumid and reniform whorl sections of *"A" complexus* (figured in this work as text figs. 8cg, 9o). Hall and Meek (1856) illustrated only juvenile specimens, and had only juvenile specimens to study. However, they did not illustrate all of their specimens.

Horizon and localities.—UT–57 is from the Dessau limestone, Thirteenth Street and East Avenue, Austin, Texas. It is Lower Campanian and was collected by W. S. Adkins in 1930. It may represent the juvenile of *Eupachydiscus jimenezi* (Renz). WSA–60–63 are from the base of the Upper Campanian, and may not belong to the same species as UT–57. They are from the Pecan Gap chalk, Walnut Hill, about 7½ miles east of Austin, Travis County, and were collected by W. S. Adkins in 1951. They occur with *Hoplitoplacenticeras* sp. aff. *Metaplacenticeras* (?) *bowersi* Anderson. There is no locality data on UT–30733.

Genus EUPACHYDISCUS Spath, 1922

EUPACHYDISCUS GORDONI, n. sp.

Pl. 16, figs. 1–3; text fig. 8e

Holotype.—UT–16, from formation C at Ray's Bluff, Brushy Creek, Travis County, Texas; collected by J. E. Gordon.

Specific characters.—Oligogyral, excentrumbilicate, subgradumbilicate, moderately subangustumbilicate, rounded venter. The whorl section is roughly circular, but slightly depressed, HF/W ranging from 0.75 to 0.90. The greatest intercostal width is just dorsad of mid flank, and at the 60 mm. diameter the greatest costal width is just dorsad of mid flank, migrating to the umbilical bulla at the 75 mm. diameter.

Costation consists of raised, strong ribs, projected, asymmetrical in section with the steep face orad. On the venter of the last whorl there are approximately 44 ribs, of which about 20 reach the umbilicus and terminate as umbilical bullae; two ribs bifurcate unevenly at one bulla, leaving about 20 intercalating ribs.

From the face of the last whorl it can be seen that the holotype is entirely septate; none of the septa show up on the cast because the surficial shell layers had not been removed at the time the shell and internal mold became one solid calcite cast. Body chamber and aperture are unknown.

Measurements are as follows:

D	U	HF	W	HF/W
UT–16				
60.0	25 0	45.0	50.0	0.90
30.0	30.0	45.0	60.0	0.75

Remarks.—*Eupachydiscus gordoni*, n. sp., is a calcite cast that cannot be compared to any of the Texas pachydisciines. *E. gordoni* recalls the costation of *Nowakites savini* (Grossouvre), but has a greater number of umbilical tubercles and the whorl section of a *Eupachydiscus*. The ribs are sharper, less regularly spaced than on other forms with similar costation, and the individual does not have the prominent bifurcations common to most species of *Nowakites*. No constrictions can be observed. Since the individual is a calcite cast it could not be cleaned, because the debris is a part of the cast and a part of the larger calcite crystal.

Horizon and locality.—Only the holotype is known. *Eupachydiscus gordoni*, n. sp., is probably from formation C, Ray's Bluff, on Brushy Creek, Travis County, Texas. Collected by J. E. Gordon. This individual is Upper Santonian, but was not found in association with other fossils. Faulting prevents exact correlation with beds in adjacent localities.

EUPACHYDISCUS JIMENEZI (Renz, 1936)

Pl. 14, figs. 1, 5; pl. 16, fig. 4; text fig. 10k

=*Pachydiscus* (*Parapachydiscus*) *jimenezi* Renz, 1936, pl. 2, figs. 4, 4a, p. 3, 4

Holotype.—Presumably the individual illustrated by Renz (1936) on Plate 2, figs. 4, 4a, no. 1 in the Böse-Staub collection, Geological Institute of the University of Bern. According to Renz his individual is from the middle Austin chalk, thought to be Santonian, but see below.

Remarks.—Included here in *Eupachydiscus jimenezi* (Renz) is one poorly preserved individual. It is oligogyral, concentrumbilicate, subgradumbilicate, subangustumbilicate; venter rounded. The whorl section is wider than high, HF/W ranging from 0.86 to 0.95; greater figures are probably the result of sedimentary distortion. The greatest costal and intercostal widths are usually at the umbilical bullae.

Costation consists of many fine intercalating and bifurcating costae of two sizes, the larger bifurcating or single from umbilical bullae, all passing over the venter without interruption. There are from 13 to 15 umbilical bullae. This compares with about 14 on the individual illustrated by Renz (1936, pl. 2, figs. 4, 4a). UT–30496 has over 60 costae on the venter, which compares to about 57 for Renz's specimen. The individual is septate throughout.

Measurements are as follows:

D	U	HF	W	HF/W
UT–30496				
75.0	23.5	45.5		
45.0	24.5	51.0	53.5	0.95
E. jimenezi (Renz, 1936, pl. 2, figs. 4, 4a)				
125.0	19.5	50.0	56.0	0 90
100 0	26.0	48.5		
75.0	24.0	45.5		
60.0	29.0	46.5		

Eupachydiscus jimenezi (Renz) as here interpreted, is extremely variable in costation. The species is more densely costate and finer ribbed than other species of *Eupachydiscus.*

Horizon and locality.—UT–30496 is from the base of the Burditt marl, Lower Campanian, at the bridge across Little Walnut Creek, Highway 291 (road to Manor), Travis County, Texas. Collected by Josh Oden.

EUPACHYDISCUS sp.

Pl. 17, figs. 2, 7; pl. 18, figs. 1, 2, 3; pl. 19, fig. 2; text figs. 8j, 10af

Specific characters. —Oligogyral, concentrumbilicate, subgradumbilicate, subangustumbilicate; venter broadly rounded. The whorl section is wider than high throughout, HF/W ranging from 0.76 to 0.99. The latter figure is probably from an individual compressed by sedimentary load. The whorl section is a depressed oval intercostally, the costal section similar, but modified by the umbilical bullae.

Costation consists of large, prosiradiate ribs, passing over the venter, but reduced over the siphuncle. The ribs appear to be symmetrical in section, and 10 to 12 of them, per volution, terminate at the umbilical margin with umbilical bullae. The other 21 to 27 ribs are intercalated, most of them just dorsad of mid flank. The range in number of ribs per volution is from 32 to 40.

All individuals are septate throughout, but no sutures could be reproduced.

Measurements are as follows:

D	U	HF	W	HF/W
UT–19871				
75.0	26.0	45.5	53.5	0.85
55.0	27.5	51.0	60.0	0.85
WSA–276				
125.0	17.0	54.5	55.0	0.99
100.0	17.5	53.0	60.0	0.88
75.0	18.5	52.5	63.0	0 83
68.0	16.0	52.0	60.5	0.86
WSA–278				
125.0		50.5	52.0	0.97
50.0		57.0	68.0	0.84
35.0		44.5	58.5	0.76

Remarks.—*Eupachydiscus* sp. agrees reasonably well with *E. haradai* (Jimbo) in the diameter of the umbilicus, the thickness of the conch, and the height of the whorl. The intercalation of secondary costae in *E. haradai* is less consistent in occurring just dorsad of mid flank than in *Eupachydiscus* sp. and the ribbing is much coarser in *E. haradai.*

The ribs are narrower throughout *E. launayi* (Grossouvre) and *E. isculensis* (Redtenbacher) than on *Eupachydiscus* sp. There is an increase in the relative width of the intercostae to costae in *E. grossouvrei* (Collignon) not present on *Eupachydiscus* sp.

In addition to the 3 individuals for which the measurements are given above, UT–1146, UT–129, and UT–170 are all fragmental individuals of *Eupachydiscus* sp.

Horizon and localities.—WSA–276 and WSA–278 are from the Dessau limestone on Tequesquite Creek, just below the culvert on the Del Rio–Eagle Pass Road, Kinney County. UT–1146 and UT–19871 are from the Austin chalk, but no other information is available on these two specimens. UT–129 is from the Dessau limestone, bed *g* of Durham (1949), Turnersville Creek Crossing, Travis County, Texas. It was collected by myself. UT–129, WSA–276, and WSA–278 are all from the Dessau chalk, and are Lower Campanian. UT–170 may be a different species, but poor preservation prohibits more accurate information; it is from the *Prionocycloceras* zone (either lowest Santonian or Upper Coniacian), San Gabriel River, 1 mile above the bridge on Highway 104, Williamson County, Texas. Another specimen, BEG–20289, is from Arroyo Tecolote, Coahuila, Mexico, associated with *Bevahites costatus* Collignon, *Exogyra laeviuscula* Römer, and *Inoceramus* sp.

Family MUNIERICERATIDAE Wright, 1952

Genus MUNIERICERAS Grossouvre, 1894

MUNIERICERAS ? TWININGI, n. sp.

Pl. 20, figs. 1, 4; text fig. 11q

Holotype.—UT–30500, from the upper part of the Boquillas-Terlingua unit of Moon (1953), Higo Pass, Agua Fria Quadrangle, Brewster County, Texas; collected by C. Gardley Moon.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, widely angustumbilicate to narrowly subangustumbilicate (U from 15.0 to 19.0). The whorl section is higher than wide (HF/W from 1.95 to 2.10), greatest intercostal width being at the first $\frac{1}{4}$ to $\frac{1}{3}$ of the flank and the greatest costal width near mid flank. The whorl section does not change during the ontogeny. The keel is high and serrate.

Costation is moderately dense with approximately 35 ribs on the outer whorl. The ribs fade out on the flank, but reappear as low umbilical nodes. The last four costae visible are split at the projected ventrolateral bullae. Costae are 2 to 3 times the width of the intercostae.

Tuberculation consists of low, rounded, wide, projected ventrolateral bullae, and small, bead-like, nodate umbilical nodes. As in most pseudoschloenbachiines and munierciceratines there are many intercalations of at least two grades. Serrations continue to the maximum diameter, and on the last half of the whorl there appear to be about 6 serrations for every 5 costae.

Overlap appears to be dorsad of mid flank. Aperture, body chamber, and suture are not recoverable.

Measurements are as follows:

D	U	HF	W	HF/W	
UT–30500 (holotype)					
115.0	15.5	48 5	24.5	1 98	34± ribs per
100.0	16.5	44 5	21.5	2 07	volution
75.0	18 5	48 5	23.5	2.06	

Remarks.—In the first draft of the manuscript I originally described *Muniericeras ? twiningi,* n. sp., as a pseudoschloenbachiine, and I am not now certain that the change to *Muniericeras* can be justified. The costation is much reduced from that of known species of *Muniericeras,* although the umbilical and ventrolateral tubercles are still extant. The highly and regularly serrate keel is certainly munierishould ceratine, unless this is part of a serrate barroisiceratine lineage that should be separated from another lineage of "*Pseudoschloenbachia,*" assuming that the type species of *Pseudoschloenbachia* belongs to this other lineage. The homeomorphy of certain species of *Barroisiceras, Pseudoschloenbachia,* and *Muniericeras* is amazing, providing presently inferred lineages are at all correct. Certainly *M. twiningi,* n. sp., is not difficult to separate from other, more ornate species of *Muniericeras* with their strong costation.

However, it is more difficult to separate *M. twiningi* from some species of *Pseudoschloenbachia* with their reduced and projected ribs on the ventrolateral areas. Probably the most reliable criteria for determining *M. twiningi* are the continually serrate keel and the splitting of the ventrolateral bullae on the larger individuals.

Horizon and locality.—Same as for the holotype. There is a specimen in the U. S. National Museum from the Tombigbee formation, U. S. G. S. Mesozoic locality 17202, which seems to belong to the genus

Munierieras, but probably not to *M. twiningi*, n. sp.

Superfamily HOPLITACEAE Douvillé, 1890

Family PLACENTICERATIDAE Hyatt, 1900

Genus PLACENTICERAS Meek, 1870

Johnston (1904) separated from *Placenticeras s. s.* those ammonites with broader venter, simpler suture, and greater ornamentation; he called this genus *Stantonoceras*. From the Campanian of the Gulf Coast are also known *Placenticeras* **Meek and *Hoplitoplacenticeras* Spath.** There is insufficient material from the Gulf Coast of the United States to allow for a revision or even an intelligent discussion of the Campanian Placenticeratidae. This will await thorough study of collections from the eastern Gulf Coast, particularly from Lowndes County, Alabama, and of collections from the San Carlos and Ojinaga formations of Trans-Pecos Texas and adjacent Chihuahua, Mexico. *Stantonoceras*, as a distinct genus, has not been universally accepted.

Subgenus STANTONOCERAS Johnston, 1903

Type species.—*Ammonites guadalupae* Römer, 1852 (= *Stantonoceras pseudocostatum* Johnston, 1903).

Remarks.—*Stantonoceras* was created by Johnston (1903) for those species with typical placenticerine juveniles, but developing quadrate to less than quadrate whorl sections in the adult. The sutures are reduced, and nodes are accentuated. This genus seems to represent a separate lineage, since smoother placenticerines occur much earlier. Juvenile *Placenticeras planum* (Hyatt) cannot always be differentiated from juvenile *S. sancarlosense* (Hyatt) or *S. newberryi* (Hyatt) or *S. guadalupae* (Römer), although in the latter two species tumid whorls may appear at earlier diameters. There is some doubt as to the validity of the subgenus, or even some of its species, other than under a typological concept, because representatives of all of the above mentioned species (*P. planum*, *S. sancarlosense*, *S. newberryi*, and *S. guadalupae*) can be found in the same thin bed at one locality.

STANTONOCERAS GUADALUPAE (Romer, 1852)

Pl. 21, figs. 2, 3, 6

Synonymy.—Reeside (1927a) has adequately covered the synonymy.

Holotype.—The holotype is the specimen figured by Römer (1852, pl. 2, figs. 1ab).

Remarks.—Little improvement can be made on Reeside's (1927a) description until the tremendous San Carlos fauna is restudied. Certainly there are complete morphological clines from *S. guadalupae* (Römer) to *S. newberryi* (Hyatt) and to *S. sancarlosense* (Hyatt) and from these to *Placenticeras planum* (Hyatt). For the time being I am following a strictly typological practice until the Placenticeratidae can be restudied.

Horizon and localities.—The specimen illustrated on plate 21 is from the Terlingua formation on Fizzle Flat, Agua Fria Quadrangle, Brewster County, Trans-Pecos Texas, collected by C. Gardley Moon. The holotype described by Römer (1852) is from the Lower Falls of the Guadalupe River, a locality now within the city limits of New Braunfels, Comal County, Texas, just under the bridge of the Missouri Pacific railroad. The holotype is presumably from the Dessau limestone, in spite of Adkins' (1933) statement to the contrary, although the Dessau limestone is thin at that locality. Since my discussion of this species (Young, 1959) Miss Constance Wollman has collected two specimens of *Stantonoceras guadalupae* from about the middle of the Dessau limestone on Williamson Creek, Travis County, in association with *Australiella pattoni* n. sp., *Submortoniceras tequesquitense* n. sp., and *Parapuzosia paulsoni*, n. sp. Reeside (1927a) and Johnston (1904) described *S. guadalupae* from New Mexico.

Adkins (1933) tried to validate his idea on the Campanian age of *S. guadalupae*, mostly on intuition, by suggesting that it was from the Taylor clay. Muller and

Schenck (1943) list *S. guadalupae* as Santonian, and Wright (Arkell, Kummel, and Wright, 1957) lists it as Campanian, but I do not know why, unless these authors also used their intuition. Until 1958 (Young, 1958a, 1959) the beds from which the holotype of *S. guadalupae* was collected were listed as Santonian. Adkins (1933) got around this by assuming that Römer's (1852) chalk designation was in error. Adkins' intuition was, as usual, running true to form; his mistake was in assuming *S. guadalupae* came from the Taylor clay. Instead he should have assumed an error in the correlation of fossils from the Austin chalk with their "supposed" counterparts in the European section.

STANTONOCERAS SANCARLOSENSE (Hyatt, 1903)

Pl. 17, fig. 6; pl. 21, fig. 7; pl. 22, figs. 1, 2; pl. 78, fig. 2; pl 80, figs. 5, 6

Synonymy.—For the synonymy I desire to follow, the reader is referred to Reeside (1927a).

Holotype.—Neither Reeside (1927a) nor Hyatt (1903) list a holotype; apparently none has been selected.

Horizon and localities.—In the San Carlos area, Trans-Pecos Texas, the comparative stratigraphic ranges of *S. sancarlosense* (Hyatt) and *S. guadalupae* (Römer) have not yet been studied. On Fizzle Flat, Agua Fria Quadrangle, Trans-Pecos Texas, C. Gardley Moon collected a specimen of *S. sancarlosense* (Pl. 22, figs. 1, 2) in association with *S. guadalupae*. The specimens illustrated on pls. 17, 21, 22, and 80, are from the Gober chalk or nearly equivalent beds, and are associated with *Delawarella danei* Young, *D. delawarensis* (Morton), and *Parapuzosia paulsoni*, n. sp. These are from the zone of *Delawarella delawarensis* and are younger than the Austin chalk species of *Stantonoceras guadalupae* from the *Submortoniceras tequesquitense* zone of the Dessau chalk. *S. sancarlosense* is Lower Campanian.

STANTONOCERAS PSEUDOSYRTALE (Hyatt, 1903)

Pl. 22, figs. 4, 5

Synonymy.—The synonymy for this species has adequately been covered by Reeside (1927a).

Horizon and localities.—Reeside (1927a) has described this species from the Omera Mine in New Mexico, and Hyatt (1903) from the San Carlos area, Trans-Pecos Texas. Several specimens are in the collections of the U. S. National Museum, from Lowndes County, Alabama. I have only one specimen, from the Dessau chalk, UT–10167, from the Keelersville area, Williamson County, collected by A. E. Hartwig.

Genus HOPLITOPLACENTICERAS Spath, 1922

The species described herein are not closely allied to the group of *Hoplitoplacenticeras plasticus* (Paulcke), but instead appear to me to be more closely related to *Haresiceras* Reeside (1927a) or to *Metaplacenticeras ? bowersi* Anderson (1957). Wright (Arkell, Kummel, and Wright, 1957) is most certainly correct when he says that the "genus is probably too widely drawn," and the group of *Hoplitoplacenticeras marroti* (Coquand) probably needs a new generic name. However, I do not propose such a revision on the meager material at my disposal.

HOPLITOPLACENTICERAS MARROTI (Coquand, 1859)

Pl. 2, figs 5, 15, 17; pl. 17, figs. 3, 4; pl 20, figs. 2, 3, pl 21, figs 1, 4; pl 81, fig. 4, text figs. 9bcf, 11a

=*Ammonites Marroti* Coquand, 1859, p 995
=*Hoplites vari* Schluter sp var. *marroti* Coquand in Grossouvre, 1894, pl. 8, figs. 3ab; pl. 9, figs. 2ab, 3ab
=*Hoplitoplacenticeras* aff. *vari* in Adkins, 1933, p. 407, 461, 473, 474, 476

Holotype.—Apparently a holotype has never been designated. Designation of a holotype depends on the condition of European collections and the correctness of Grossouvre's identification of his forms with those of Coquand. These questions cannot be decided from Texas.

Remarks.—With the rather poorly preserved and scarce material in my possession little can be added to the description given by Grossouvre (1894). The ribs are sigmoid, cross the venter, and bear ventrolateral nodes and umbilical nodes. The ribs are usually flattened on the outer one-half of the flank. The ventral nodes are more pronounced, costation is coarser and more sparsicostate, and the umbilical tubercles more pronounced than in species of *Haresiceras* Reeside (1927a). Certainly Grossouvre (1894) erred in placing "*Ammonites*" *striatocostatus* Schlüter (1872, pl. 20, figs. 1 and 4 only) in synonymy with the species illustrated by him.

Metaplacenticeras ? bowersi Anderson (1958) has straighter ribs and the whorl section is not as high as in *Hoplitoplacenticeras marroti* (Coquand). There seems to be little difference between the Texas forms and those described by Grossouvre (1894). *Hoplitoplacenticeras vari* (Schlüter) in Basse (1931, pl. 5, figs. 1, 2, 3) is more sparsicostate and has heavier and more sigmoid ribs than the Texas forms of *H. marroti* (Coquand).

Measurements of BEG–20495 are as follows:

D	U	HF	W	HF/W
55 0	30.0	49.0	34.5	1 42
40.0	27.5	50.0	30.0	1.33

Horizon and localities.—Although Spath (1953) lowers the base of the Maestrichtian to include the zone of *Hoplitoplacenticeras vari*, it is doubtful if the great number of micropaleontologists can ever be inveigled into following such a classification; Reiss (1955) is very adamant against it. I am here placing the base of the Upper Campanian at the base of the zone of *Hoplitoplacenticeras vari*. In Texas *H. marroti* is known from the Wolfe City sand, and the Anacacho limestone of South Texas. In addition a specimen in the U. S. National Museum, U. S. G. S. Mesozoic locality 16465, seems to belong to *H. marroti*. It is from the Anacacho limestone, but the costation is coarser than on the other Texas individuals. It was collected by A. N. Sayre in 1933 from the Anacacho limestone on Grosebacher Road, 1 mile south of Potranca Road, Bexar County. Other specimens known to me are BEG–20495 and BEG–20496, from the Anacacho limestone, Medina-Bexar County line; BEG–34772, from the Anacacho limestone, San Geronimo Creek, north of Cliff, Medina County; and BEG–34774. The latter is the specimen reported by Adkins (1933, p. 461, 476) from the Wolfe City sand, from the Gulf, Colorado and Santa Fe Railway cut, about 1½ miles east by north of Wolfe City, Hunt County, collected by Sargent in 1929. The outcrop for BEG–34774 was illustrated by Stephenson (1918, pl. 29b).

HOPLITOPLACENTICERAS sp. aff. METAPLACENTICERAS ? BOWERSI Anderson, 1958

Pl. 20, figs. 7–9; text figs. 9dhk

=*Hoplitoplacenticeras* sp. aff. *vari* Adkins in Feray and Plummer, 1949, p. 62

Compare—Metaplacenticeras ? bowersi Anderson, 1957, p. 255, pl. 70, figs. 3, 4, 4a

Remarks.—A fragment of a small, poorly preserved individual in the Adkins collection appears to be related to Anderson's (1958) species, *Metaplacenticeras ? bowersi*. It has the same intercalated ribs, squat whorl section in juveniles, umbilical bullae, and short ventral clavae. The height-width ratio is unity. Although coarser, the costation is also reminiscent of "*Ammonites*" *lemfordensis* Schlüter (1876, pl. 44, figs. 8 and 9), but Schlüter illustrates both ventral and marginal nodes, whereas the Texas form has only one row of nodes ventrolaterally.

Horizon and locality.—WSA–59 is from the base of the Pecan Gap chalk, Walnut Hill, about 7½ miles east of Austin, Travis County, Texas, Bureau of Economic Geology locality 226–T–29; Base of the Upper Campanian, zone of *Hoplitoplacenticeras vari*.

Superfamily ACANTHOCERATACEAE Hyatt, 1900

Family COLLIGNONICERATIDAE Wright and Wright, 1951

Subfamily PERONICERATINAE Hyatt, 1900

I am here following the taxonomy of Wright in Arkell, Kummel, and Wright (1957). If more than one subfamily is used for the post-Turonian Collignoniceratidae, as proposed by Collignon (1948) and followed by Wright, several would have to be proposed if a polyphyletic taxonomy were to be avoided. If the texanitines are included in the subfamily Peroniceratinae, the subfamily is still polyphyletic in the same sense that the Hoplitaceae are polyphyletic (Wright, 1955). *Australiella* is the biggest problem in trying to develop a taxonomy that is not polyphyletic. Certain species of *Delawarella* vary sufficiently for one subspecies to be assigned to *Delawarella* and the other subspecies to be assigned to *Australiella.* These I have placed in *Delawarella.* In addition some forms assigned to *Australiella* have been derived directly from *Prionocycloceras* or *Protexanites,* without passing through any other texanitine lineage, whereas others appear to have been derived through a pentatuberculate texanitine lineage. Other texanitines are derived from *Peroniceras* through *Texanites stangeri* (Baily) and its subspecies. These different taxonomic problems will be discussed more completely under the various genera, but it should be emphasized that Texanitinae, as used by Collignon (1948), is composed of two, perhaps three lineages, one derived from within the subfamily and two derived separately from the Peroniceratinae. These do not include the various sublineages within the genus *Submortoniceras.*

If only the subfamily Peroniceratinae is used, the polyphyletism is at least retained within the one subfamily, but it leaves the question of polyphyletism of genera unsolved.

Genus **PRIONOCYCLOCERAS** Spath, 1926
(=*Donjuaniceras* Basse, 1951)

Type species.—*Ammonites guayabanus* Steinmann in Gerhardt, 1897.

Generic characters.—Oligogyral, concentrumbilicate, subangustumblicate to narrowly latumbilicate, subgradumbilicate; normally carinate. However, the keel may be lost on the body whorl and may be serrate in the young of some species. The intercostal section is higher than wide, oval; the costal section is subrectangular.

The costae may be simple and single, or there may be two grades of costae, the secondary costae not reaching the umbilicus in the adult forms. Secondary costae are without terminal nodes at the umbilicad ends. On those species in which the juveniles are known, the texanitine clavae are well developed on some, absent on others; they may be incipient, effaced, or well developed in the adult.

Remarks.—The adult of *Prionocycloceras guayabanum* (Gerhardt) has not previously been illustrated. An adult individual from the Adkins collection is illustrated on Pl. 23, figs. 5, 6; Pl. 27, figs. 2, 3; and text figs. 12a, 14a, and 33d. This individual has part of the living chamber preserved, and also retains a short fragment of the apertural margin. It has little similarity to the juvenile illustrated by Gerhardt (1897, pl. 5, figs. 22abc), but it is logical development from the ontogenetic stage he illustrated.

Whereas the young show only single ribs, the adult possesses both primary and secondary ribs, is horned, the primary ribs distinguished only by their ventrolateral horns on the body chamber. Ribbing is sparse. The other important feature is that the last whorl bears the incipient texanitine clava (fifth or external). The derivation of the texanitine clava in this species may be important. It is not quite obvious from Pl. 23, figs. 5 and 6, that the small ventrolateral tubercle becomes texanitine when a large ventrolateral horn arises just dorsolaterad; but this is its derivation. Whether all texanitine tubercles have this derivation is not known to the writer, but the incipient external tubercles on Gerhardt's (1897) illustrations must have been texanitine functionally, if not by definition.

I am not convinced of the distinction which most paleontologists seem to expect between *Prionocycloceras* Spath and *Protexanites* Matsumoto. Good specimens of *Australiella* Collignon are thought to be from the upper part of the Lower Santonian, appearing with *Texanites texanus*

texanus (Römer) in the zone of *Inoceramus undulatoplicatus*. These early *Australiella* seem to be derived from *Prionocycloceras* or *Protexanites* directly, their derivation depending on the generic assignation of such species as *Protexanites shoshonensis* (Meek) and *Prionocycloceras adkinsae*, n. sp., the latter from the upper part of the Chispa Summit formation of Trans-Pecos Texas. The development of 5 tubercles may be part of a program phenomenon in texanitine evolution, just as the texanitine clavae appear to represent a program phenomenon. Such species of *Australiella* as *A. austinensis*, n. sp., appear earlier than do species of other subgenera of *Menabites*, and it is now within reason to expect species of *Prionocycloceras, Australiella*, and *Protexanites* to appear at one and the same horizon, although such an occurrence has yet to be reported. *Protexanites* possesses a consistent texanitine fifth clava supposedly at all diameters. This is not true of the holotype of *Prionocycloceras, P. guayabanum*, and is not true of *P. gabrielense*, n. sp., in which the texanitine clavae disappear on the body chamber. Body chambers of *Protexanites* have yet to be described.

On the other hand, in some horned Texanitinae the ventral clavae are of little or no taxonomic value, just as similar clavae are of no taxonomic value in some horned Mantelliceratinae, other than that they are present at some stage of the ontogeny. Whatever organ is responsible for the marginal (fourth) horn became so large during the development of the horn that it masked the effect of the organ producing the external clava. When for some reason, as on the body chamber, the horn is no longer required, the effect of the organ producing the ventral clava is no longer masked and the clava reappears. Functionally it was never masked; it was just masked by the larger organ (e.g. *Graysonites lozoi* Young, 1958a, pl. 27, figs. 1–11 and text figs. 1c and 1d). In horned species, then, it frequently becomes necessary to ignore the apparent absence of external clavae. If the disappearance of external clavae is ignored, the distinction between *Prionocycloceras* and *Protexanites* is restricted to the presence of secondary ribs in the former and their absence in the latter; or to a more dense, slightly sigmoid costation in the former, with more sparsicostate, rectiradiate ribs in the latter. By this method of differentiation alone some species are *Prionocycloceras* in the juvenile stages and *Protexanites* in the adults, and vice versa. Another distinction that can be used with some success is the presence of umbilical tubercles in *Protexanites* and their absence in *Prionocycloceras*, but such a distinction is not always consistent; *Prionocycloceras maarfiaense* Sornay (1957a) has the general appearance here attributed to *Protexanites*.

Most of the studies on the development of the keel in Collignoniceratidae have been made from one specimen. I suspect that this keel development varies greatly from specimen to specimen; certainly there is no empirical evidence to show that the ontogenies of the keels on different individuals of the same species follow exactly the same pattern. This assumption of consistent keel development is one of the acts of faith so typical of science, but not always borne out. However, at different diameters on the few specimens known, the keel development in *Prionocycloceras* is quite different. On *P. guayabanum*, as published by Gerhardt (1897), the keel is serrate; prior to the body chamber, and on the first ½ of the body chamber of WSA–137, it is low, rounded, and smooth; on the last ½ of the body chamber of WSA–137 the keel disappears entirely. On the last (body) chamber of *P. gabrielense*, n. sp., the keel disappears also. On the other hand *Prionocycloceras adkinsae*, n. sp., retains the keel, and on this feature alone should be assigned to *Protexanites*, but other features indicate the *Prionocycloceras* assignment followed in this work. Body chambers, however, are so rare that they are no more than taxonomic obstacles in these larger Peroniceratinae. The nodate or serrate keel of *Prionocycloceras* may be very important, but there is some indication that the serration is restricted to the shell and not present on the keel of the molds. Thus the feature is not useful in the Senonian forms of the Gulf Coast in which no shell material is preserved. Fundamentally this is the same type of a problem that Collignon (1955) encountered in the Pachydiscidae in which he found it difficult to identify molds with shells of the same species. Since body chambers of *Protexanites* have yet to be described, the entire taxonomic status of these two genera remains up in the air. *Protexanites shoshonensis* (Meek) (Reeside, 1927c, pl. 7, figs. 1–11; pl. 8, figs. 1–4) may be atypical because of the incipient lateral tubercle which can be observed on the individuals and faintly in Reeside's illustrations. The individual illustrated by Haas (1949, pl. 9, fig. 2) shows the incipient lateral tubercle more clearly, when studied, but Haas gives only a ventral view.

The genera *Protexanites* and *Prionocycloceras* are not always distinct from *Collignoniceras* either. For instance compare the figures of "*Prionotropis*" *woollgari* var. *praecox* of Haas (1946, pl. 17, figs. 1–5) with *Prionocycloceras hazzardi*, n. sp. (pl. 26, figs. 1 and 2), *Protexanites planatus* (Lasswitz) (pl. 26, figs. 3, 4; pl. 35, fig. 4; pl. 36, figs. 1, 2; pl. 37, figs. 2–4) and *Prionocycloceras gabrielense*, n. sp. (pl. 24, figs. 1–3; pl. 29, fig. 5; and pl. 67, fig. 1). Although it is easy to find criteria to differentiate these as species, to find features to use for generic criteria is more difficult. Unfortunately the samples are too poorly preserved and too small for quantitative work. Fortunately *Protexanites planatus*, *Prionocycloceras hazzardi*, and *P. gabrielense* all occur above undoubted *Peroniceras*-bearing strata, whereas *Collignoniceras* and *Prionocyclus* are older.

Since more information is necessary to determine the status of *Protexanites* and *Prionocycloceras*, I am following the more standard treatment of Wright (Arkell, Kummel, and Wright, 1957) and holding in abeyance any decision on the taxonomic structure of the post-Turonian Collignoniceratidae.

PRIONOCYCLOCERAS GUAYABANUM (Steinmann in Gerhardt, 1897)

Pl. 23, figs. 5, 6; pl. 27, figs. 2, 3; text figs. 12a, 14a, 33d

=*Prionocyclus guayabanus* (Steinmann) in Gerhardt, 1897, p. 197–198, pl. 5, figs. 22abc, text fig. 19

=*Prionocycloceras guayabanum* (Steinmann in Gerhardt) Spath, 1926, p. 80

=*Donjuaniceras longispinata* Basse, 1951, pl. 11, figs. 1–4

Specific characters.—Oligogyral, concentrumbilicate, widely subangustumbilicate, carinate. The whorl section is higher than wide (HF/W from 1.25 to 1.35), intercostal section oval, costal section subrectangular at diameters greater than 100 mm. The flanks are flattened in the younger growth stages, and intercostal width is greatest at the first 1/3 of the flank, costal width being greatest at the ventrolateral horns.

The keel is serrate to beyond a diameter of 60 mm., becoming low and indistinct by a diameter of 100 mm. and disappearing completely on the last 1/2 of the body chamber, at a diameter of about 150 mm.

Costation is sparse, there being about 17 single primary costae at a diameter of 60 mm.; at larger diameters the primary costae become sparser and secondary costae are intercalated until at a diameter of 200 mm. there are about 1/2 dozen horn-bearing primary costae and roughly 15 secondary, hornless costae. The tubercles are hollow and the shell is about 0.8 mm. thick at the base of the horn at a diameter of 200 mm., thickening toward the end of the horn to a thickness of 1.2 mm. On the venter the shell is about 0.7 mm. thick and 1.3 mm. thick on the flank at a diameter of 200 mm. At a diameter of 130 mm. the shell is about 0.7 mm. thick on the flank and venter. The horns are large and conical. Tuberculation consists of long, low, umbilical bullae on the primary ribs at younger diameters, but these are visible at adult diameters only if they are searched for; in the adults secondary ribs bear low ventrolateral clavae directed forward and ventrad. These ventrolateral clavae become texanitine on the primary ribs when the horn arises at the ventrolateral position; the horns are directed laterad.

On WSA–137 septation ceases at about the 110 mm. diameter, and the living chamber occupies about 240° to a diameter of about 220 mm.

The suture is gauthiericerine with reduced secondary and tertiary elements. The first lateral saddle is wider than normal to accommodate the large horns, when they are present, but unlike many horned ammonites, the saddle remains wide even in the absence of the horn.

Measurements of the large individual, WSA–137, are:

D	U	HF	W	HF/W	P	S	B	T
215.0	30 5	41 0			6	15		21
135 0	32 0	45 5	35 6	1.28				
105.0		50 5	38.0	1.33				

Remarks.—This is apparently the first illustration of an adult of *Prionocycloceras guayabanum* (Gerhardt). The large adult can be differentiated from most species of *Prionocycloceras* by the many secondary ribs. In this respect it is similar to *P. hazzardi*, n. sp., but the ribs on the former are not as pronounced at diameters of from 100 to 200 mm. *P. gabrielense*, n. sp., is more densicostate up to diameters of 150 mm., and has none or only a few secondary ribs. *P. gabrielense* is also much more evolute than is *P. guayabanum*, and since the young stage of *P. gabrielense* is unknown, it may eventually be assigned to *Protexanites*. Gerhardt (1897, pl. 5, figs. 22abc) shows the incipient texanitine clavae, and Basse (1951) also illustrates the horns in the fourth position with the marginal tubercle in the fifth position when the horn is present. *P. mediotuberculatum* (Gerhardt) and *P. pitalensis* (Gerhardt) do not possess the texanitine clavae, at least not at the ontogenetic stages illustrated by Gerhardt. Sornay's (1957a) juvenile *P. maarfiaense* has more the appearance of a *Protexanites*.

The large specimen in the Adkins collection, WSA–137, has faint texanitine clavae, but the individual must be observed closely to see these. The derivation of these external clavae is of interest because the ventrolateral tubercles of the primary ribs are actually texanitine in position. When the ventrolateral horn arises on the primary rib, then the tubercle that has always been called the ventrolateral or marginal (fourth) tubercle actually is displaced to the fifth position and the new ventrolateral horn becomes the fourth or marginal tubercle. I doubt that all texanitine clavae develop in this way, but in this group the development is quite definite.

Basse's (1951) specimens were not whitened before photography and it is difficult to ascertain the presence and nature of the fourth tubercle (incipient horn). "*Donjuaniceras*" *longispinata* Basse (1951) is certainly a synonym of *Prionocycloceras guayabanum* (Gerhardt). *Prionocycloceras*, n. sp., indet. Basse (1951, pl. 11, figs. 7ab) appears to be the juvenile of *Prionocycloceras mediotuberculatum* (Gerhardt).

Horizon and locality.—*Prionocycloceras guayabanum* (Steinmann) is said to be from the Lower Coniacian of Venezuela, and WSA–137 and WSA–317 are from the type locality, near Chejendé, Venezuela. They were collected by W. S. Adkins in 1952.

PRIONOCYCLOCERAS sp. aff. GUAYABANUM (Steinmann in Gerhardt, 1897)

Pl. 25, fig 1; pl. 34, fig 5; text fig. 15b

Remarks.—A large fragment of a species of *Prionocycloceras* from Trans-Pecos Texas may belong to Gerhardt's species. It differs from *P. guayabanum* in the development of strong umbilical tubercles on the horned ribs. The specimen, BEG–34741, is not large enough to determine if there are many secondary ribs, and one flank is extremely corroded. The whorl section agrees reasonably well with that of *P. guayabanum*.

Horizon and locality.—The specimen, BEG–34741, of *Prionocycloceras* sp. aff. *guayabanum* (Gerhardt) is from the Fizzle Flat lentil of the Terlingua formation

(Moon, 1953) from the Agua Fria Quadrangle, Brewster County, Trans-Pecos Texas. It was collected by W. S. Adkins and John Twining in 1953.

PRIONOCYCLOCERAS ADKINSAE, n. sp.

Pl. 23, figs. 1–4; text figs. 25f, 28g, 34e

Holotype.—WSA–94A, from the upper part of the Chispa Summit formation, Capote Ranch, near Chispa Summit, Trans-Pecos Texas.

Specific characters.—Oligogyral, concentrumblicate, subgradumbilicate, probably sublatumbilicate, but only fragments are known. The whorl section is wider than high intercostally, and subcircular, widest near mid flank. The costal section is nearly rectangular, and is of course widest at the ventrolateral horns. Costation is prominent and sparse, there being one or two secondary ribs per whorl with a total of about 12 or 14 ribs per whorl at diameters of about 75 mm. The other 10 to 12 ribs are primary. Ribs are inconsistently spaced, the intercostae ranging from 1 to 2 times the width of the costae. Diameters of less than 50 mm. are still unknown. All costae are single on all individuals.

Tuberculation consists of low, slightly bullate nodes at the dorsal ends (umbilical) of the primary ribs, and ventrolateral horns. The horns are usually flattened ventrodorsally, but some are circular in cross-section. Most primary ribs contain horns, but one or two per whorl may not. Some secondary ribs contain horns. In addition the texanitine (fifth) clava is persistent on all individuals observed, there being one external clava per rib.

All known specimens are fragments of body chambers.

The height and width of the holotype and several paratypes follows. Figures marked with an asterisk are in mm.

HF*	W*	HF/W
Holotype WSA–94A		
27.0	31.0	0.87
21.0	21.0	1.00
Paratype WSA–94		
25.5	23.0	1.11
25.0	25.5	0.98
20.5	20.5	1 00
23.0	22.0	1.04

Remarks.—*Prionocycloceras adkinsae,* n. sp., is another species that could be assigned to either *Protexanites* or *Prionocycloceras,* or even *Australiella.* I have selected *Prionocycloceras* for this species because of the secondary costae and the lack of pronounced umbilical tubercles. It has only one clava (fifth tubercle) per rib, whereas all species of *Australiella* so far described have more than one clava per rib. However, some such species as *Prionocycloceras adkinsae* probably gave rise to the Lower Santonian species of *A. austinense,* n. sp. *P. adkinsae* is differentiated from other species of the genus by its height-width ratio of around one or less, and by costation much more like that of *P. hazzardi,* n. sp., than species of *Protexanites*—that is with the ribbing very reduced at mid flank. *Prionocycloceras adkinsae* is very reminiscent of *Protexanites shoshonense* (Meek), and particularly its subspecies *crassum* (Reeside), if the latter had ventrolateral horns and a few secondary ribs. In Reeside's pictures (1927c, Pl. 8) the tubercles have been accented by retouching, but the ribs are considerably stronger at mid flank than are those of *Prionocycloceras adkinsae,* n. sp. Also on *P. adkinsae* there is no indication of the incipient lateral tubercle splitting off from the umbilical tubercle as there is on *Protexanites shoshonense crassum* (Reeside), and also on *P. shoshonense* (Meek).

Horizon and locality.—Five incomplete individuals are known of *Prionocycloceras adkinsae,* n. sp. They were collected by W. S. Adkins from a small hill on the side of the Candelaria Road, ¾ mile west of the Capote Ranch house, Presidio County, Trans-Pecos Texas. Bureau of Economic Geology locality 3304.

PRIONOCYCLOCERAS GABRIELENSE, n. sp.

Pl. 24, figs. 1–3; pl. 29, fig. 5; pl. 67, fig. 1; text fig. 21c

Holotype.—UT–10808, Upper Coniacian; from formation B, 1 mile east of the

Georgetown-Jonah (Highway 104) highway bridge across the San Gabriel River, on the south bank of the San Gabriel River, Williamson County, Texas.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, sublatumbilicate (U = 32.0–46.5), carinate. The whorl section is higher than wide (HF/W is 1.25), but most fossils are so flattened by sedimentary processes that thickness measurements are meaningless.

Flanks are flattened in earlier whorls, becoming rounded at diameters of 250 mm. or more; costal width is about the same at the marginal tubercle as at the umbilical tubercle.

Costation is moderate, with slightly sinuous ribs to the 150 mm. diameter, sparse with slightly projected ribs beyond the 150 mm. diameter. Costae and intercostae are about the same width up to the 120 mm. diameter, then the costae become sparser until on the last volution intercostae are twice the width of the costae. The costae prior to the 150 mm. diameter are low, not pronounced, and there are no observable bifurcations or intercalations.

Tuberculation consists of slightly bullate umbilical tubercles which hang over the umbilical margins to a diameter of about 175 mm., after which they become more bullate, more pronounced, and are slightly removed from the umbilical margin. There are also marginal (ventrolateral) tubercles which become short horns at about a 270 mm. diameter. The horns on UT–10808, the holotype, are directed laterad to ventrolaterad. In addition there are external (texanitine) clavae at all observable diameters except the last half of the body chamber. Thus there are three tubercles per side.

The conch is almost evolute, overlap being to between the external and marginal tubercles. On the holotype septation ceases at about the 340 mm. diameter, and part of the body chamber is present.

The measurements of two individuals are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–10808 (holotype)								
365.0	46.5	30.0	24.5?	1.22?	14			14
300.0	45.0	32.0			18			18
250.0	40.5	31.0			22	2		24
200.0	34.0	34.0			25—	5—		30—
150.0	35.5	38.0						
100.0	35.5	38.5						
UT–18109A								
285.0	34 0	29.0	21.0	1.38	20—			20—
160.0	44.0	31.5	26.5	1.19	19—			19—

Remarks.—Of two ammonite experts who have visited Austin in the past few years, one has maintained that *Prionocycloceras gabrielense*, n. sp., could not be a *Prionocycloceras* and the other thought that it should be classified in this genus. Part of the indecision or difference of opinion is because only small specimens or juveniles of the type species, *P. guayabanum* (Gerhardt) have been published. A large individual of *P. guayabanum* in the W. S. Adkins collection is 200 mm. and more in diameter, yielding information not found in the juveniles. The juveniles of the type species show a texanitine tubercle only slightly, and the large individuals have only an incipient texanitine clava. Whether this clava is incipient because in *P. guayabanum* a texanitine clava is just entering the lineage, or whether it is a holdover, or whether it is masked by the ventrolateral horns as are similar clavae in *Graysonites* Young (1958a) and some species of *Collignoniceras* Breistroffer, I cannot at this time say, but masking is doubtful in this species because the texanitine clava is more prominent on the secondary low ribs than on the large horned primary tubercles. Certainly in consistently horned collignoniceratines the presence or absence of the texanitine (fifth) clava are dubious taxonomic criteria, and it is within reason to have an external clava on some species of *Prionocycloceras* Spath throughout the ontogeny. There is further confusion, moreover, because outer whorls of large species of *Protexanites* Matsumoto are almost identical with the outer whorls of some species of *Prionocycloceras gabrielense*, n. sp. The inner whorls and costation can be maintained to be generically different. Furthermore, large whorls of species of sparsely costated *Gauthiericeras* sp., *Protexanites*, sp., and *Prionocycloceras* sp., when flattened and crushed by sedimentary processes so that the external clavae cannot be seen, are almost impossible to tell apart. Whether such forms as the isolated body chamber, UT–18109B (Pl. 29, fig. 5) with the faint keel on the latter part of the body chamber, and costation recalling that of certain Mammitinae, belong to *Prionocycloceras* or not, cannot be definitely determined, but this individual is probably the body chamber of *P. gabrielense*, n. sp.

Although large whorls of *Prionocycloceras* and *Protexanites* are much alike, the slightly sinuous, denser costation of the younger whorls of *P. gabrielense*, n. sp., differentiate it from the younger whorls of *Protexanites planatus* (Lasswitz).

In addition to the individuals for which measurements are given above, UT–18109B, UT–1485, and UT–30669 belong to this species.

Horizon and localities.—All individuals of *Prionocycloceras gabrielense*, n. sp., in the collections studied by myself, are from the lower part of formation B and upper part of formation A. They appear to be from the Upper Coniacian, but associated ammonites are rare in Texas. The species is known from Travis County and Williamson County. UT–30669 is from a sewer ditch near the Physics Building on The University of Texas campus at Austin. UT–1485 is from the top of formation A, Palm Valley area, Williamson County. An individual in the U. S. National Museum, U. S. G. S. Mesozoic locality 7699, is from Seco Creek, Medina County.

PRIONOCYCLOCERAS HAZZARDI, n. sp.

Pl. 24, fig. 4; pl. 25, figs. 2, 3; pl. 26, figs. 1, 2; pl. 27, fig. 4; pl. 34, fig. 2; pl 39, fig. 3; text figs. 12f, 13bd, 14g, 20h

Holotype.—BEG–34740, from the Fizzle Flat member of the Terlingua formation, Agua Fria Quadrangle, Brewster County, Texas; collected by Adkins and Twining, 1953.

Specific characters.—Oligogyral, concentrumbilicate, narrowly sublatumbilicate, carinate. The whorl section is higher than wide (HF/W about 1.5), but the holotype is greatly flattened by sedimentary load. The juvenile whorls are unknown. Flanks are flattened in later whorls and the costal width is much greater at the ventrolateral horn, when these are present. Costation is sparse, with 9 ribs on the whorl ending at a diameter of 500 mm. and 12 ribs on the whorl ending at 350 mm. Intercostae are 2 to 2½ times as wide as the costae. The ribs are rectiradiate and end at the shoulder horn.

Tuberculation consists of three tubercles including large umbilical nodes, ventrolateral horns, rather low on the shoulder, and rather low, indistinct external clavae, which are pronounced only on the last half of the ultimate whorl.

Overlap is to the shoulder tubercle. BEG–34740, the holotype, is septate to about 300 mm. diameter. Another specimen is septate to at least 205 mm.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
BEG–34740 (holotype)								
520.0	35.5	39.5	25.0—	1.57—	9			9
380.0	38.0	37.5	crushed		10			10
315.0	38.0	35 5	crushed		12			12
unnumbered in Adkins collection								
218.0	31.0	39.0	20.0—	1.93—				

Remarks.—The above description of *Prionocycloceras hazzardi*, n. sp., is largely of the holotype, since there is no certainty that the two smaller individuals actually belong to the same species as the holotype, although all are from the same locality and horizon. *P. hazzardi*, n. sp., differs from other species of the genus in the more dorsad positioning of the ventrolateral tubercle in the adult and in the more pronounced development of the umbilical nodes at all diameters. An individual in the Adkins collection also belongs to this species and agrees with the holotype. The subquadrate section is also typical of this species.

As in other species of *Prionocycloceras* from the platform limestone facies, all of the individuals are large. Whether or not some of the forms described by Gerhardt (1897), Basse (1951), Bürgl (1957), Besaire (1936), or Sornay (1957a) are juveniles of these extremely large species cannot possibly be determined until juveniles of the large individuals are better known. At that time some of my species might prove to be synonymous with previously described species.

Horizon and locality.—*Prionocycloceras hazzardi*, n. sp., probably belongs to the Upper Coniacian. The individual in the Adkins collection and the holotype, BEG–34740, are from the Fizzel Flat member of the Terlingua formation, Agua Fria Quadrangle, Brewster County, Trans-Pecos Texas. Individuals which may belong to this species are from the upper part of formation A, 1½ miles north of Weir, Williamson County, and from 4½ miles south of Georgetown, on the San Gabriel River, Williamson County, Texas.

Genus PERONICERAS Grossouvre, 1894

I do not propose to revise the genus *Peroniceras* on the limited material from the Gulf Coast of the United States. However, fossils which I have assigned to Reyment's (1957) subgenus *Reginaites* I do not believe to belong to *Peroniceras*. Consequently the reader will find *Reginaites* discussed under the Texanitinae in this work.

PERONICERAS HAASI, n. sp.

Pl. 34, figs. 3, 4; pl. 35, figs 1–3

Holotype.—The holotype of the species is UT–10175, from formation A, Lower Coniacian, from ½ mile south of Weir on Weir Branch, Williamson County, Texas. Collected by A. E. Hartwig.

Specific characters.—Serpental, concentrumbilicate, widely sublatumbilicate (U from 44.0 to 51.0), subgradumbilicate, tricarinate. Height is probably greater than width, but all individuals have been flattened by sedimentary load. Flanks are flattened in all whorls, but this may also be the result of sedimentary load. The intercostal width is greatest at mid flank, and the costal width is greatest at the umbilical tubercle. Costae and intercostae are about the same width.

Costation is moderate, with rectiradiate ribs terminating at umbilical and marginal tubercles. The ribs are weak, low, and rounded in cross section, and there are bifurcations on whorls of less than 50 mm. diameter, larger whorls containing only single and primary ribs, with a few intercalations. The number of ribs ranges from 24 to 34 per volution. Tuberculation consists of clavate marginal tubercles and nodate to bullate umbilical tubercles; the tubercles are low and simple. Overlap is to the marginal tubercles. UT–10175 appears to have part of the body chamber present, but preservation is not good enough to make any statements concerning its size.

Measurements of three individuals are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–10175 (holotype)								
150.0	48.0	29.5			22	2		24
100.0	50.5	31.0			17	2	4	27
UT–18125								
100.0	44.0	32.0			24	10		34
75.0	42.5	34.5						
50.0		39.5						
UT–10172								
60.0	45.0	31.0						
40.0	45.0	35.0						

Remarks.—*Peroniceras haasi*, n. sp., has the general aspect of the pictures of *Peroniceras tricarinatum* (d'Orbigny) in Schlüter (1872, pl. 13, figs. 1, 2), which Grossouvre places in *Peroniceras subtricarinatum* (d'Orbigny). However, Grossouvre's illustrations (1894, pl. 10) are slightly more densicostate than is Schlüter's or the individuals from Texas herein described as *P. haasi*. D'Orbigny's species is more strongly costate also, than is *P. haasi*, and *P. westphalicum* (Schlüter) is much more strongly costate than is *P. haasi*. *P. dravidicum* Kossmat (1898) has many bifurcations throughout the ontogeny, whereas *P. haasi* has only a few, and those on the early whorls only. *Peroniceras stefaninii* Venzo (1936) is more coarsely costate than *P. haasi*, as is also *P. westphalicum* var. *australis* Venzo.

In addition to the three specimens for which measurements are given there are one in the U. S. National Museum, three in the Bureau of Economic Geology, and seven in the Department of Geology, The University of Texas.

Horizon and localities.—In addition to the three individuals for which measurements are given above, several more fragmental individuals are known from Williamson County, about 30 feet above the base of formation A. An additional individual was collected from the basal 15 feet of the Austin chalk on Bouldin Creek, Travis County, by the writer, and still an additional individual is in the U. S. National Museum, from U. S. G. S. Mesozoic locality 7699, Austin chalk, bed of the bank of Seco Creek, about 7 miles above the Galveston, Harrisburg & San Antonio railroad bridge, Medina County; it was collected by L. W. Stephenson in 1911. UT–19032 is from the basal 20 feet of the Austin chalk at Watters Park, Travis County. Two specimens in the Bureau of Economic Geology, BEG–17209 and BEG–17210, are from Uvalde and Kinney Counties, the first from Lindsey Creek and the second from West Elm Creek, collected by H. C. Fountain. All are Lower Coniacian.

PERONICERAS MOURETI Grossouvre, 1894

Pl. 26, fig. 5; pl. 27, fig. 1; text fig. 13a

=*Peroniceras moureti* Grossouvre, 1894, pl. 11, figs. 3, 4abc; Venzo, 1936, pl. 9, figs. 1ab

=? *Ammonites czornigi* (Redtenbacher) in Fallot, 1885, pl. 1, figs. 1abc

=? *Peroniceras* aff. *cocchi* Menegh. in Riedel, 1932, pl. 30, figs. 1, 1a, 1b, 2

Measurements of Texas individuals are as follows:

D	U	HF	W	HF/W	P	S	B	T
estimated from Grossouvre's Pl. 11, fig. 4								
116.0	53.5	26.0	23.5	1.09	37			37
100.0	54.5	25.0	21.0	1.19	34			34
75.0	52.0	29.5			33			33
60.0	37.0	30.0			31			31
40 0	47.5	30.0						
WSA–220								
262.0	60.5	21.0			37—			37—
200.0	56.5	24.0			35—			35—
150.0	54 5	27.5			33			33
100.0	53.0	33.0						
UT–19937								
103.0	52.5	27.0	21.0	1.27	41			41
78.0	50.0	28 0	25.0	1.13	38			38
60.0	48.5	31 0			37			37
40 0	48.5	33.5			33			33

Remarks.—Of the specimens herein assigned to *Peroniceras moureti* (Grossouvre, 1894), WSA–220 is almost identical with Grossouvre's (1894) individual illustrated on his Pl. 11, fig. 4. UT–19937 is slightly more densicostate than Grossouvre's specimen, but with fewer costae than the individual illustrated by Fallot (1885) as "*Ammonites*" *l'epeei.* UT–19937 has the number of costae comparable to *P. subtricarinatum tridorsatum* (Schlüter) in Grossouvre (1894, pl. 10, fig. 3a), but is less evolute. *Peroniceras czörnigi* (Redtenbacher) is generally higher whorled than *P. moureti* and with slightly sinuous costae, not present in *P. moureti. P. rousseauxi* also has ribbing similar to *P. moureti*, but has a much more depressed whorl section. Some of the crushed specimens illustrated by Burckhardt (1919) as *P. subtricarinatum* Stürm, *non auctorum*, may belong to *P. moureti*, but other specimens illustrated by Burckhardt are much more densicostate.

In all individuals of *P. moureti*, including Grossouvre's, the ribs are all primary, concave orad, and somewhat prosiradiate. There is a small umbilical bulla near the umbilical end of each rib, and a shoulder clava at the other end of each rib.

Horizon and localities.—According to Grossouvre (1894) *Peroniceras moureti* is most typical of the Lower Coniacian. Of the American specimens UT–19937 is from the small fault block just west of the main fault on Alligator Creek, south part of the Hunter Quadrangle, 1.9 miles S 30° E (airline) of Hunter, Comal County, Texas. WSA–220 is from the "Lower Anacacho" limestone (= Austin chalk), on the Anacacho Ranch, Uvalde County, and was collected by H. C. Fountain.

PERONICERAS WESTPHALICUM (Schluter, 1867)

Pl. 28, figs. 2–4; pl. 29, figs. 1, 2; text fig. 15d

=*Ammonites westphalicus* Schlüter (1867), p. 30, pl. 6, fig. 2; Schluter, 1872, p. 45, pl. 13, figs. 5 and 6

=*Peroniceras westphalicum* (Schlüter) Grossouvre, 1894, pp. 98–100, pl. 12, figs. 1, 4ab; Adkins, 1933, pp. 407, 453

Specific characters.—Polygyral, concentrumbilicate, subgradumbilicate, widely sublatumbilicate to narrowly latumbilicate (U from 43.0 to 58.0), tricarinate. The whorl section is higher than wide, according to Grossouvre (1894), with a ratio of 4:3. Since the individuals from Texas are flattened by sedimentary load, the restoration of the smaller section of text fig. 15d may be to too great a thickness. The intercostal section is ovoid whereas the costal section is subquadrangular. Costal width is about equal at the umbilical and ventrolateral tubercles at younger diameters, but beyond a diameter of 150 mm. the shoulder tubercles become greatly reduced and the greatest costal width is at the umbilical tubercle. The greatest intercostal width is at or near mid flank.

Costation is generally sparse to moderate, with straight, blunt ribs, generally rectiradiate except where there is an accommodation of a primary rib to one of the rare intercalated secondary ribs. Between the tubercles ribs are low and rounded in section. The number of ribs ranges from 16 or more on UT–83 to about 25 on fig. 4 of Grossouvre's (1894) pl. 12, at the 100 mm. diameter, and at greater diameters ranges from 17 to 22 ribs per whorl. WSA–19 is more sparsely costate than other individuals. Costae and intercostae are about the same width throughout most of the ontogeny. At diameters of 100 mm. there may be bifurcations, and there are more bifurcations on Grossouvre's (1894) pl. 12, fig. 4, than on other individuals, thus accounting for the greater number of total costae on this specimen. The number of primary costae is remarkably constant, and beyond the 100 mm. diameter there are few if any bifurcations, but there are rare intercalations of short secondary ribs with the accompanying ventrolateral tubercles.

Tuberculation consists of a strong, bullate umbilical tubercle placed just ventrad of the umbilical wall, and nodate to clavate ventrolateral tubercles positioned on the shoulder. WSA–19 maintains the typical nodate to clavate shoulder tubercles at a diameter of greater than 350 mm., and UT–83 compares very well with Grossouvre's specimen to more than the 200 mm. diameter.

The conch is almost evolute, overlap being to ventrad of the shoulder tubercles. Grossouvre's individuals are septate throughout, as are those illustrated by Schlüter (1872). UT–83 is septate to a diameter of 212 mm., the maximum diameter. WSA–19 is septate to beyond the 350 mm. diameter, so the aperture of this species is still unknown. The sutures on the Texas individuals are too poorly preserved to reproduce.

Measurements of several individuals are as follows. Some measurements are incomplete because the fossils are crushed. The measurements for Grossouvre's individuals are estimated from his (1894) pl. 12, figs. 1, 4, and 4a.

D	U	HF	W	HF/W	P	S	B	T
WSA–218								
300.0	57.0	23.5			20			20
250.0	54.0	22 5			19			19
200.0	50 0	24 5			16			16
150.0	53 5	25.5			17			17
100.0	55.0	28.0						
WSA–19								
350 0	57.5	25.5			20			20
300.0	56 5	27.0			18			18
250.0	56 5	27 0			17			18
200.0	55 5	23 5						
150 0	52.5	23.5						
100.0	53.0	25.5						
75.0	52.0	27.0						
UT–93								
200.0	51 5	27.5			16	4		20
150.0	50.5	28.5			17	3		20
100.0	49 0	25.5						
Grossouvre's Pl. 12, fig. 1								
93.0	52.0	27.0			21	1		22
75.0	52.0	28.0			20—	1		21—
50.0	52.0	28.0						

D	U	HF	WHF/WP	S	B	T
Grossouvre's Pl. 12, figs. 4, 4a						
112.0	47.0	32.0		16	9	25
75.0	51.5	31.5		17	6	23
50.0	45.0	34.0		13	3	5 26

Remarks.—Two of the individuals of *Peroniceras westphalicum* (Schlüter), as here described, fall within the range of variation of the individuals figured by Grossouvre (1894). WSA–19 is slightly more sparsely costate than Grossouvre's. The total number of individuals described for this species by all authors does not constitute a sample sufficiently large for even small sample analyses, and as Spath (1923) has pointed out, as have later authors, species described on small samples will be much less variable than those described on large samples. This is the result of both the collection of less variability and of a human element.

Peroniceras westphalicum is more strongly costate and more sparsely costate than are other species of the genus. *Peroniceras moureti* Grossouvre has sharper and more numerous ribs, with an orad concavity (ribs are projected) not present on *P. westphalicum*. *P. haasi*, n. sp., and *P. subtricarinatum* (d'Orbingy) have more costae per volution and the costae are not as strong. *P. dravidicum* Kossmat has many more bifurcating ribs at larger diameters than does *P. westphalicum*. The costation of the Texas forms is much like that of *Peroniceras stefaninii* Venzo (1936), which species I would place in synonymy with Schlüter's on the basis of the illustration, but the whorl section given by Venzo may not be typical of *P. westphalicum; P. westphalicum australis* Venzo also falls within the sparsicostate range of *P. westphalicum*. Grossouvre's individual is somewhat gradational from these more coarsely ribbed, sparsely costate, single ribbed forms to *P. dravidicum* Kossmat with its many bifurcations.

In the University of Texas collections there are seven individuals that can be definitely assigned to *P. westphalicum* and one individual on which the assignment is questionable.

Horizon and localities.—*Peroniceras westphalicum* (Schlüter), according to Grossouvre (1894), is from the Lower Coniacian. WSA–218 is from the Agua del Fuerte (Lindsey Creek), about 5 miles NNE of Spofford, from the "Lower Anacacho" limestone (=Austin chalk) of Kinney County, Texas, and WSA–19 is from the "Lower Anacacho" limestone on the Anacacho Ranch, Uvalde County, Texas, collected by H. C. Fountain. UT–18 is from formation A, 5½ miles east of Georgetown on the San Gabriel River, Williamson County, Texas. Other individuals are from Weir Branch, ½ mile south of Weir, Williamson County, Texas.

Subfamily TEXANITINAE Collignon, 1948

Nearly all of the texanitines from Texas are internal molds in carbonate rocks. For this reason the younger whorls are seldom seen, usually because they cannot be extracted from the matrix without their shattering. Some success is obtained with a vibratool, but only on fossils on which the matrix is partially weathered or is chalky. Consequently, without being able to study his first two or three ontogenetic stages, I have not been able to test Collignon's (1948) classification of the Texanitinae thoroughly, and sometimes his classification breaks down. With *Australiella* Collignon, of course, and some forms of *Menabites* Collignon, the trituberculate stage (stage 3) is retained to diameters sufficiently large to be observed. In other forms [e.g., *Menabites densinodosus* (Renz) and *M. internodosus* (Renz)] the trituberculate stage had not been observed and these species and similar species are included in this genus for other reasons. Incidentally I have not been able to identify *M. internodosus* (Renz) in any of the material available to me.

In *Delawarella* the trituberculate stage sometimes disappears at earlier diameters, and this genus is then also difficult to work with. In some species of *Delawarella*, after the quadrituberculate stage is obtained, the marginal (fourth) tubercle becomes so dominant as to mask the submarginal (third) and the fossil then superficially resembles *Australiella* again.

The following key has been used to classify species into the various genera in the many forms in which the younger whorls could not be observed; although practical the key may not always be correct when a final analysis is made and the true lineages eventually learned.

A. Bituberculate stage at gerontic diameters; the bituberculate stage consists of the first tubercle plus a tubercle formed by the joining of tubercles 4 and 5 together ....*Submortoniceras.*

B. Trituberculate beyond the 50 mm. diameter.
   1. Trituberculate throughout (tubercles 1, 4, and 5) ....*Australiella.*
   2. Trituberculate followed by pentatuberculate ....*Menabites.*
   3. Trituberculate followed by quadrituberculate, then pentatuberculate; sometimes followed in a gerontic stage by trituberculate, with 2 effaced and a middle tubercle formed by the fusion of 3 and 4, or sometimes returning to the trituberculate by the masking of 2 and 3 by ventrolateral horns (4) ....*Delawarella.*

C. Pentatuberculate
   1. With tubercles 3 and 4 close together and on a raised or more prominent part of the rib..........*Bevahites.*
   2. With intercalated ribs and more external tubercles (5) than marginal tubercles.
      a. Tubercles 3 and 4 close together and on a raised prominence; U = 30 to 45..........*Bevahites.*
      b. Tubercles 3 and 4 more separated, not on a raised prominence; U = 17 to 40; tubercles 2 or 3 or both effacing ....*Submortoniceras.*
   3. U = less than 30.... *Submortoniceras.*
   4. No intercalated ribs; few or no bifurcation at diameters greater than 100 mm.; same number of external (5) and marginal (4) tubercles ....*Texanites.*
   5. Bifurcations at umbilical (1) and/or lateral (2) tubercles.
      a. Quadrate whorl section ....*Delawarella.*
      b. High whorl section ....*Submortoniceras.*
   6. Effacement of all tubercles except umbilical (1) and external (5) at diameters of more than 100 mm. ....*Submortoniceras.*

D. Bituberculate venter without keel ....*Defordiceras.*

E. Tricarinate, with all but umbilical and marginal tubercles effacing on the outer whorls ....*Reginaites.*

Like most artificial keys this one breaks down at certain controversial boundaries, but it is usually applicable when most of the ontogeny, and particularly the early ontogeny, is unknown.

I have not been able to use Collignon's (1948) subgenera of *Menabites* to complete satisfaction. *Delawarella* can be successfully separated in those species in which ribs bifurcate at the umbilical (1) or lateral (2) tubercles, but some *Delawarella* cannot be successfully identified unless the entire ontogeny can be unravelled. There appears to be no species of *Bererella* in North America. As a result of these taxonomic difficulties one or more species are described only as *Menabites sensu lato*, without assigning a subgenus.

Genus PROTEXANITES Matsumoto, 1955

PROTEXANITES PLANATUS (Lasswitz, 1904)

Pl. 26, figs 3, 4; pl. 35, fig. 4; pl. 36, figs. 1, 2; pl. 37, figs. 2–4; text figs. 20a, 25m, 29c

=*Schloenbachia quattuornodosum* var. *planata* Lasswitz, 1904, p. 32, pl. 7, fig. 4

=*Mortoniceras quattuornodosum* var. *planatum* (Lasswitz) in Adkins, 1928, pl. 34, fig. 3

=*Texanites planatus* (Lasswitz) in Young and Marks, 1952, pp. 480, 481

=*Bererella planata* (Lasswitz) in Collignon, 1948, fasc. 14, p. 44 (*101*)

Holotype.—I cannot find that a holotype has ever been designated; it has always been assumed that the one internal mold illustrated by Lasswitz (1904, pl. 7, fig. 4), which is the only individual heretofore illustrated, had to be the holotype. It was called holotype by Adkins (1928) in the description of Pl. 34, but not in the text. In addition this specimen was also illustrated by Adkins (1928, Pl. 34, fig. 3). It was in the Römer collection at the University of Breslau (Adkins, 1928), and presumably this is where Adkins photographed it. A cast is in the Bureau of Economic Geology, The University of Texas, Austin, Texas, and Adkins' illustration may be of the cast. However, I think not, because he was unusually careful in such designations. The fossil is said to be from the capitol excavation at Austin (Lasswitz, 1904), Travis County, Texas, but see discussion below. According to a letter from Turner to W. S. Adkins, there is also a cast of this specimen at the Texas Agricultural and Mechanical College, College Station, Texas.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, widely subangustumbilicate to narrowly sublatumbilicate (U from 30 to 40), carinate. The whorl section is higher than wide (HF/W from 1.2 to 1.4). The HF/W reading of 1.4 appears to be on a crushed individual.

Intercostally the position of greatest width varies from just dorsad of the umbilical tubercle to mid flank. At younger diameters up to 75 mm., the costal width is greatest at the ventrolateral (marginal) tubercle, but at more advanced diameters the greatest costal width is at the umbilical tubercle.

Costation is sparse throughout, the number of ribs per volution ranging from 15 to 19. Costae are about ⅔ of the width of the intercostae and are either slightly prosiradiate or they are rectiradiate, swinging slightly forward ventrad of the marginal tubercle. Costae are weakest just dorsad of mid flank, and, as in many texanitines, terminate with the external clavae.

The umbilical tubercle is bullate throughout, sometimes split with a ventral portion and a dorsal portion (UT–30504 and UT–14398A, but not UT–14398B). The marginal tubercles are almost horns at younger diameters (up to 100 mm.), but are nodate beyond, and the external clavae are long and narrow, being raised a little on the latter part of the body chamber of UT–30504.

Overlap may or may not cover the marginal tubercle, but remains near the marginal tubercle. On UT–30504 septation ceases at about the 100 mm. diameter and the body chamber occupies at least 270°, a rather large body chamber for such an oligogyrate conch. The apertural margin is not preserved.

A suture could not be recovered from any of the fossils in the collections.

Measurements of several individuals are as follows:

D	U	HF	W	HF/W	P	S	B	T
Holotype								
75 0	34.5	38.5			15			15
60.0	36.0	40 0						
50.0	36.0	43.0						
40.0	40.0	45 0						
30.0	40.0	40.0						
UT–14398B								
60 0	31.0	40.0	31.0	1.29	16—			16—
40.0	31.0	42.5	34.0	1.25				
UT–30504								
150.0	36.0	38.5	30 0	1.28	19			19
125.0	36.0	39 0	32.0	1.22	18			18
100.0	33.0	37.5	31.0	1.21	18			18
80.0	32.0	39.5	32.5	1.21	18—			18—
UT–14398A								
75.4	37.0	36.5	26 0	1.40	15—			15—
60.0	37.0	35.0	29.0	1.24				

Remarks.—*Protexanites planatus* (Lasswitz) is reminiscent of *P. bourgeoisi* (d'Orbigny), but in the younger whorls has less ribs per volution; the ribs are stronger in *P. planatus* and the umbilical tubercles more bullate in *P. bourgeoisi*.

Presumably Lasswitz's figure (1904, pl. 7, fig. 4) was responsible for Collignon [1948, fasc. 14, p. 44 (*101*)] placing this species in *Bererella*. Also the genus *Protexanites* had not at that time been proposed. However, the figure 4 of Plate 7 of Lasswitz is not good; neither is his illustration of *Drakeoceras maximum* (Lasswitz's Pl. 6, fig. 2) when compared with the cast of the original. On the other hand his illustrations of *Manuaniceras* (Lasswitz's Pl. 4, figs. 3ab, and pl. 5, figs. 1

and 2) are fairly accurate in interpretation, if not in detail.

Thus the double umbilical tubercles of Lasswitz's Pl. 7, fig. 4, are misleading. Adkins' (1928, pl. 34, fig. 3) photograph shows only one split umbilical tubercle. Two of the individuals at hand have 2 or 3 split tubercles, the other individual has none. On individuals of other coarsely costate species the same effect as the split tubercle is achieved if one umbilical bulla is crushed by sedimentary load, the greatest collapse occurring in the middle of the bulla, resulting in two small nodes. *Protexanites shoshonensis* (Meek) has progressed a bit further in tuberculation with the development of a lateral tubercle, still displaced umbilicad, and with the umbilical tubercle then much less pronounced. Also *P. shoshonensis* is just a bit more evolute, but not beyond the realm of specific variation unless the differences prove consistent in larger samples than are now known.

Lasswitz (1904, p. 10) says that his specimen presumably (vermütlich) came from the capitol, and Adkins (1928, description to pl. 34 and p. 252) makes this a fact by omitting the "vermütlich"; thus another example of Simpson's "indestructibility of error." It is possible that the label had been lost or that the Austin collector had not bothered to label the fossil. Römer (1888) states that Mr. Stolley had sent him a great many fossils, and those from the capitol excavation had to be received in Germany long after Römer had left the United States, because the excavation was not started until many years after Römer's departure.

According to Lasswitz the following fossils were collected from the capitol excavation: *Texanites texanus* (Lasswitz, *non* Römer) [= *T. roemeri* (Yabe and Shimizu)] and *Texanites americanus*. The latter has been collected by Clarence Durham from the type locality of *T. texanus texanus* (Römer) and from approximately the same horizon. Lasswitz further says that the following fossils presumably came from the capitol excavation: *Texanites minutus*, *"Schloenbachia" quattuornodosa*, and *Protexanites planatus*. If these three also came from the excavation, then one Coniacian and two Santonian zones are represented. The local rocks are of such thickness that this is improbable, even with the fault which transects the capitol grounds and which is known to fault an Upper Coniacian part of the Austin chalk against the Upper Santonian part of the Austin chalk under the capitol building. I do not believe that all of the fossils so listed by Lasswitz came from the one capitol excavation unless some of them had been reworked into the Pleistocene terrace gravels, and collected from them at the site of the capitol excavation.

Whether the large individual, UT–18019, belongs to *Protexanites planatus* or to some other species cannot be ascertained. In addition to those specimens for which measurements are listed above, UT–80, UT–111, UT–78, UT–30688, UT–172, UT–32229, UT–10169, and questionably BEG–F632 also belong to *P. planatus*.

Horizon and localities.—Two of the individuals of *Protexanites planatus* (Lasswitz) have long ago been separated from any labels they might have had, but because of the careful work of J. L. Patton (1932), information on a third is still intact: UT–30504 is from 1 mile east of the Highway 104 (Georgetown-Jonah) bridge over the San Gabriel River, Williamson County, and is from formation B, lower part. Marks collected other specimens, UT–80, UT–111, UT–172, and UT–30688, from the same locality. At the present writing a new bridge is being built not far from the old one, but it is the old low-water bridge from which this locality is taken. The two unlabeled individuals, UT–14398A and UT–14398B, have the same lithology and are also probably from formation B. This is probably the Upper Coniacian and should be about the same horizon as *Prionocycloceras gabrielense*, n. sp. Grossouvre (1894) shows *Protexanites bourgeoisi* (d'Orbigny) as Upper Coniacian and Lower Santonian, but Collignon (1948) appears to restrict this species to the Coniacian. *P. planatus* (Lasswitz) is also known from part of the *subquadratus* zone of Young and Marks (1952) where it occurs in the upper part of formation A, on Weir Branch, Williamson County. Eight specimens are known from the San Gabriel River section in Williamson County.

Genus PARATEXANITES (PARABEVAHITES) Collignon, 1948

PARATEXANITES (PARABEVAHITES) SELLARDSI, n. sp.

Pl. 32, fig. 7; pl. 36 figs 3–5; pl. 37, fig 1; pl. 39, fig. 4; pl. 49, fig. 3; text fig. 17

Holotype.—BEG–34745, from formation B, Williamson Creek, on the Austin-San Antonio Highway (in 1932) Travis County, Texas; collector, E. H. Sellards.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, widely sublatumbilicate, carinate; venter rounded intercostally. The whorl section is a little higher than wide if not restored; intercostal section is circular to slightly oval. Costal section is quadrangular, being rounded at the umbilical shoulders. The costal section is slightly wider at the umbilicus than ventrolaterally. The greatest intercostal width is just dorsad of mid flank.

Costation is moderately sparse with about 20 ribs per volution at the 100 mm. diameter; costae are all single, rounded, rather symmetrical in section. There are no bifurcations or intercalations. The species is quadrituberculate if the two clavae perched on the ventrolateral node are counted as two tubercles. There are then an umbilical tubercle (1), a submarginal tubercle (3), a marginal tubercle (4), and the external or texanitine clava (5); the lateral (2) is absent. The external tubercle is clavate, the submarginal and marginal slightly clavate, and the umbilical only slightly bullate. Tubercles are strong and well developed, except for the submarginal and marginal, which are on a strong, raised protuberance.

One individual, BEG–34745, may be septate throughout; certainly nothing can be determined of the aperture or the body chamber, or of the juvenile whorls. The suture is typical of early texanitines, with deep ventral lobe, wide first lateral saddle, and long first lateral lobe. All of the diverticulae are small except for the auxiliary lobe of the first lateral saddle; this is well developed, but its position varies from suture to suture (two adjacent sutures are illustrated in text fig. 17), depending on the proximity of the bulge supporting the submarginal and marginal clavae. If this bulge occupies the first lateral saddle, the auxiliary lobe is displaced far ventrad, but if the bulge is not in the first lateral saddle, the auxiliary lobe approximately divides the saddle.

A second individual, UT–30692, although too crushed to be easily measured, shows a denser costation to a diameter of about 65 mm., after which the costation becomes sparse. On the last part of the conch of this individual, the marginal and submarginal clavae are not delineated and there is one large, ventrolateral node.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
BEG–34745 (holotype)								
150 0	42.5	33.5	27.5	1.22	20			20
100 0	48.5	35 5	29.0	1.22				
85.0	46.5	33 0	30.0	1.00				
78 5	39.5	38.0			27			27
50 0	44.0	39 0						

Remarks.—*Paratexanites sellardsi*, n. sp., is intermediate between *Protexanites* and *Parabevahites*. The marginal and submarginal clavae are present, but are retained on a single ventrolateral protuberance similar to the ventrolateral tubercle of *Protexanites planatus* (Lasswitz). The corresponding tubercle in *P. bourgeoisi* (d'Orbigny) as illustrated by Grossouvre (1894) is a little more elongate spirally (clavate). Likewise the umbilical tubercles of *P. bourgeoisi* and *Parabevahites zeilleri* (Grossouvre) are more bullate than are those of *Protexanites planatus* (Lasswitz) and *Parabevahites sellardsi*, n. sp. In the same way, of these four species, *Protexan-*

ites planatus is the closest to *Peroniceras* in ornamentation, even to the extent that the external (texanitine) clavae are longer and have not been as definitely broken up from the peroniceratine keels as in the other species. Because I have so few species and so few individuals of each species I have made no attempt to reclassify these forms or to amend the genera; instead I have accepted the genera accepted by Wright (Arkell, Kummel, and Wright, 1957). I sincerely doubt the necessity for the genus *Parabevahites* Collignon (1948), but feel that my material is too meager to substantiate any decision to put it into synonymy.

The differences between *Parabevahites zeilleri* and *P. sellardsi* are not beyond the realm of variation within a species were there more individuals to illustrate such continuous variation. The greatest single difference is the tendency for the submarginal and marginal tubercles to form into one large ventrolateral tubercle in *P. sellardsi,* whereas they remain distinct in *P. zeilleri.* This phenomenon may represent the caenogenetic development of *Parabevahites.*

Horizon and locality.—The holotype of *Parabevahites sellardsi* appears to be from the lower part of formation B. Another individual appears to be either from the same horizon or a horizon in the upper part of formation A on the San Gabriel River, Williamson County, Texas. Moon (1953) collected a larger fragment, that may be from a representative of this species, from just below the Fizzle Flat lentil of the Terlingua formation in the Agua Fria Quadrangle, Brewster County, Texas. The individual from below the Fizzle Flat lentil is too large to compare easily with the Williamson and Travis County forms, but it appears to be the outer $2/5$ of a whorl of a large individual of *P. sellardsi.*

A fossil in the United States National Museum, from U. S. G. S. Mesozoic locality 7658, labeled "*Mortoniceras* aff. *bourgeoisi* (d'Orb)," belongs neither to *Protexanites planatus* (Lasswitz) nor to *Parabevahites sellardsi,* n. sp. It is closely related, but the ribs are prosiradiate and concave orad as in the stages of *Protexanites planatus* beyond the 100 mm. diameter. U. S. G. S. Mesozoic locality 7658 is in the Austin chalk, at the water hole on Cibolo Creek, $1\frac{3}{4}$ miles above Schertz, Guadalupe County, Texas. Collected by L. W. Stephenson.

Genus TEXANITES Spath, 1932

I have not departed from the interpretation given this genus by Collignon (1948), except for one or two species.

TEXANITES TEXANUS TEXANUS (Römer, 1852)

Pl. 38, figs. 1, 2; pl. 40, figs. 1–3; pl. 41, fig. 4; text figs. 21g, 22e, 25d

Synonymy.—See Collignon (1948) for synonymy.

Holotype.—The individual figured by Römer (1852, pl. 3, figs. 1a, 1b, and 1c) is the holotype. It has also been figured by Collignon (1948, text figs. 1, 1ab). All of these are poor illustrations, but Collignon's figures show the essential features of the holotype so that a cast in the Bureau of Economic Geology could be identified with them. The cast of the holotype is herein figured on Pl. 38, figs. 1, 2, and Pl. 41, fig. 4.

Measurements of two specimens are as follows:

D	U	HF	WHF/WP	S	B	T
cast of holotype						
144.0	45.0	28.5		20±		20±
100.0	41.0	33.0				
75.0	45.0	32.0				
BEG-34744						
130.0	44.0	33.5		21		21
100.0	39.5	35.0		20		20
70.0	43.0	37.0				
60.0	38.5	35.5				

Remarks.—I see no need to repeat here the good descriptions already given by Collignon (1948). He is certainly correct in his interpretation of the species and in removing all of the European forms from *Texanites texanus texanus* (Römer). It may have been necessary to make some of these *Texanites texanus auctorum* (*non*

Römer) subspecies (varieties in Collignon) of *T. texanus* in order to validate the long use of *T. texanus* as a zonal index in the standard sequence (Spath, 1926; Muller and Schenck, 1943). This necessity still exists because only 7 individuals are known to the writer besides the holotype, which is refigured herein on the basis of a cast in the Bureau of Economic Geology at Austin. The holotype is not well preserved and had never been cleaned; thus the cast can be identified with Collignon's (1948, text figs. 1, 1ab) illustrations of the holotype. The holotype has been compressed by sedimentary load, but it is the sparsity of ribbing and the shape of the ribbing and tuberculation which is so characteristic of the species, as already pointed out bv Haas (1942). The suture illustrated by Römer (1852, pl. 3, fig. 1c) was taken from the holotype; this can be determined from the cast which also shows most of the suture. Collignon's (*op. cit.*) illustrations of the holotype are accurate but do not show much detail because they were published as a text figure on poor paper. Except for the whorl section and the number of ribs, Römer's illustrations (1852, pl. 3, figs. 1a, 1b) are completely misleading, and greatly restored by the artist or the engraver. An additional individual from Trans-Pecos Texas, so badly preserved as to be specifically unidentifiable, may also be conspecific with Römer's holotype, and Collignon (1948) points out that Peron's (1897, unillustrated) "*Mortoniceıas*" *texanum* may be conspecific with Römer's species. In addition to the holotype, UT–486, BEG–20493, BEG–34744, and perhaps UT–10166 and UT–31723 belong to Römer's species.

Horizon and locality.—Many visits to the type locality of *Texanites texanus* (Römer) by various geologists have so far failed to produce a single topotype. Römer was sufficiently precise in his description of the type locality that it can be visited without difficulty; he was not so precise in some of his other localities. Römer collected the fossil at the lower rapids of the Guadalupe River, now within the city limits of New Braunfels and about 100 feet downstream from the Missouri Pacific Railroad bridge. It most certainly came from formation B.

As has been shown by Durham (1955) the section at New Braunfels is extremely thin, on the margin of the shelf called the San Marcos Platform, San Marcos Arch of Adkins (1933). *Texanites texanus texanus* seems to be older than Upper Santonian because, on the basis of Durham's work, it can be determined now that almost all of the Upper Santonian is absent in the Comal County outcrop. The Lower Santonian and Upper Coniacian are extremely thin and the very fine texanitine fauna of other areas is only spotty in Comal County. Hartwig (1952) collected a crushed specimen (UT–486) of *Texanites texanus texanus* (Römer) from near the bridge across Possum Creek, just east of New Walberg, Williamson County. This individual occurred just above an epibole of *Inoceramus undulatoplicatus* Römer, but is still within the *I. undulatoplicatus* zone; it is from the upper part of foımation B. Another individual, BEG–34744, is from the Travis Heights area, Austin, Texas; it is also from the upper part of formation B. *Texanites texanus texanus* is the middle zone of the Lower Santonian of Texas. *Inoceramus undulatoplicatus* and questionably *Australiella austinensis*, n. sp., are associated fossils.

Another individual of *T. texanus texanus* is in the U. S. National Museum, from U. S. G. S. Mesozoic locality 1514, from Cow Creek, below Pinto Creek, about 24 miles below Del Rio, Texas. It was collected by Stanton and Vaughan in 1895. The species is not yet known from the East Gulf Coast, all previous identifications of *Texanites texanus* in that area being erroneous.

TEXANITES TEXANUS subsp. GALLICA Collignon, 1948

Pl. 38, figs. 3, 4

Holotype.—In describing *Texanites texanus* var. *gallica* Collignon (1948) failed to designate a holotype. Presumably he was thinking of the individual illustrated by Grossouvre (1894), pl. 17, fig. 1, as the holotype. The synonymy has recently been given by Collignon (1948).

The measurements of BEG–F–592 are as follows:

D	U	HF	W	HF/W	P	S	B	T
125.0	39.0	36.0	32.0	1.12	24	8		32
100.0	39.5	37.5	36.5	1.03	22	7		29
75.0	34.0	33.5	33.5	1.00				

Remarks.—One fossil from the Bureau of Economic Geology, Fehr collection (F–592) seems to belong to Collignon's subspecies, *T. texanus* var. *gallica.* Unfortunately there are no notes extant concerning the Fehr collection, and the label gives no horizon or locality data; the fossil on a lithological basis seems to be from formation C. F–592 has the general appearance of the individual figured by Grossouvre (1894), both in general conch conformation and in the shape of the ribs and tubercles. Although the measurements of Grossouvre's individual as given by Collignon [1948, fasc. 13, p. 65 (*20*)] are slightly different the measurements of that form and F–592 fall within the general range of similar measurements in other species of texanitines. *T. texanus gallica* is more densicostate than *T. texanus texanus* and *T. texanus twiningi*, n. sp., and is more densicostate in younger whorls than is *T. roemeri* (Yabe and Shimizu). *T. roemeri* also has lower and broader ribs, although some individuals of *T. texanus gallica* show this tendency toward the broadening of ribs. BEG–F–592 is septate throughout.

Locality and horizon.—There is no data on BEG–F–592. The notebooks for the Fehr collection, Bureau of Economic Geology, have never been located. The lithology is neither that of the Dessau chalk nor that of formation B. Consequently it is believed that the fossil came from the intervening formation C. Such an occurrence would also agree with the entire development picture of *Texanites.* BEG–17504 is almost identical with Grossouvre's illustrated specimen; it is from the Rio Bravo collection and the locality information is lost. BEG–F–592 may be one of the specimens identified by Burckhardt (1930) from the Fehr collection as *Texanites texanus.*

TEXANITES TEXANUS TWININGI, n. subsp.

Pl. 38, fig. 5; pl. 39, fig. 1; pl. 41, figs. 2, 5; pl. 48, fig. 4

Holotype.—BEG–20480, a fragment of two peneadult whorls from the Terlingua formation, Agua Fria Quadrangle, Brewster County, Texas.

Specific characters.—The specific characters of *T. texanus twiningi*, n. subsp., are the same as for *Texanites texanus texanus* except that there are from 4 to 6 more ribs per volution; the intercostae, of course, are not as wide, and the ribs are sharper and less rounded in section on *T. texanus twiningi* than on *T. texanus texanus* (Römer).

Remarks.—*Texanites texanus twiningi*, n. subsp., appears to be a Trans-Pecos Texas subspecies of *Texanites texanus texanus* (Römer). The ribbing and degree of involution relate it to *T. texanus texanus* in every way. Actually, if the two forms, *T. texanus texanus* and *T. texanus twiningi* occurred together, there would be no need for the new name. However, all individuals but one of *T. texanus twiningi* are geographically isolated from all individuals of *T. texanus texanus.* Five specimens are known, BEG–20480, the holotype, UT–30704, UT–30697, UT–30706, and an individual in the U. S. National Museum, from U. S. G. S. Mesozoic locality 14608. *T. texanus twiningi* has much the appearance in costation and tuberculation of *T. oliveti spinosa* Collignon (1948), but the tubercles are not nearly as sharp and pointed; the whorl section of *T. texanus twiningi* is higher.

Horizon and locality.—All individuals of *Texanites texanus twiningi*, n. subsp., are from the middle shale member of the Terlingua formation (Moon, 1953). Most are from the limestone bed at the top of the shale, which limestone bed is labeled "*Texanites texanus* beds" by Moon. Presumably this horizon is the upper zone of the Lower Santonian and should correlate with the zone of *Texanites texanus gallica.* It is above the *Inoceramus undulatoplicatus* Römer zone in that area.

TEXANITES AMERICANUS (Lasswitz, 1904)

Pl. 41, figs. 1, 3; pl. 44, figs. 2, 3; pl. 48, figs. 1, 3; pl. 57, fig. 5; text fig. 24c

=*Schloenbachia bourgeoisi* d'Oıbigny, var. *americana* Lasswitz, 1904, pl. 8, fig. 1

=*Mortoniceras amerıcanum* (Lasswitz) in Adkıns, 1928, p. 252

=*Texanites bourgeoisi* (d'Orbigny) var. *americanum* (Lasswitz) ın Collıgnon, 1948, fasc. 14, p. 41 (98)

Holotype.—The original of Lasswitz's (1904) pl. 8, fig. 1, originally in the geological museum at Breslau, is apparently lost. As neotype I select UT–563, a splendid specimen from the top of formation C and illustrated on pl. 44, figs. 2, 3.

Specific characters.—Oligogyral, mildly excentrumbilicate, subgradumbilicate, sublatumbilicate, U increasing with the diameter of the shell, younger whorls having a U in the 30's and 40's, large whorls having a U in the 40's only; carinate; whorl height only slightly higher than whorl width, HF/W ranging from 1.0 to 1.1; whorl section circular intercostally; subquadrate costally. The greatest intercostal width is at mid flank or just dorsad thereof, whereas the greatest costal width is at the lateral tubercle in younger whorls, migrating to the submarginal tubercle beyond the 100 mm. diameter.

Costation is moderately sparse, ranging from 12 to 19 ribs per volution at a diameter of 50 mm. and less; possessing 19 or 20 ribs per volution at diameters from 50 mm. to 75 mm.; increasing to 24 or 25 ribs per volution at diameters of 100 mm. or more. Costae are generally symmetrical, rounded in section, and are approximately rectiradiate at all diameters, and are not projected on the venter.

The species has five tubercles at all diameters observed by the writer. The umblical and lateral tubercles are nodate at all stages. The submarginal tubercles are only slightly clavate, whereas the marginal and external tubercles are clavate. The tubercles are fairly evenly spaced. In Lasswitz (1904, pl. 8, fig. 1) the restored tubercles are too pointed.

Overlap is to a position between the marginal and submarginal tubercles. As yet I have recovered no sutures. The fragment of whorl preserved on UT–19872 at a 145 mm. diameter is apparently body chamber, but UT–563 is septate to much greater diameters.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–563 (neotype)								
300.0	58 0	27.5	21.5	1.28	29			29
250.0	55.5	24.5	20.0	1.22	28			28
200.0	52.5	27.0	22.0	1.23	26			26
175.0	52.5	23.5			24			24
150.0	50.5	24.5			24			24
125.0	53.0	26.5			24			24
100.0	49.0	25.0			22			22
75.0	52.0	26.5			25			25
50.0		31.0						
Texanites americanus (Lasswıtz's 1904, pl. 8, fig. 1).								
112.0	51.5	29.5			25			25
100.0	49.5	30.5			24			24
75.0	49.5	29.5			19		3	25
UT–19872								
145.0	45.0	35.5	32.5	1.09	20			20
88.0	45.0	36.0	34.0	1.06	19			19
75.0	42.0	34.5	34.5	1.00				
50.0	44.0	33.0	31.0	1.06				
Texanites stangeri sparsicosta (Spath, pl. 5, fig. 1) for comparison								
300.0	57.5	25.0			32			32
250.0	56.0	26.0			29			29
200.0	59.0	28.5			28			28
150.0	56.5	33.0			26			26
100.0	51.5	30.0			22			22
50.0	50.0	35.0						

Remarks.—*Texanites americanus* (Lasswitz) is a conspicuous species to which the individuals herein described are attached. Unfortunately I do not have a cast of the Lasswitz specimen (1904, p. 8, fig. 1); it has more bifurcation and sharper tubercles than the few specimens I can match with it; but the really sharp tubercles are restored and the artist probably erred. Probably the artist could count the number of ribs, but if the individual is restored as much as some of Lasswitz's other figures, the rib count on the inner whorls could be considerably in error. It is only on the inner whorls that there is any significant difference in the number of ribs between the Lasswitz figure and the individuals which I am attaching to this species. The individual described by Römer (1852, pl. 3, figs. 1d, 1e) is restored, and represents a composite of the two specimens figured by Collignon (1948, text figs. 3, 3ab, 4). These two specimens were assigned to *Texanites roemeri* (Yabe and Shimizu) by Collignon (1948) and by Yabe and Shimizu (1923). I had tried to assign them to *Texanites americanus* (Lasswitz), but the greater involution and the more clavate marginal tubercles separate these two specimens from *T. americanus.*

Haas (1942) described *T. quinquenodosus evoluta* from Angola. This fossil appears to me to belong to the more evolute group of *T. stangeri* (Baily), but the high whorl section is atypical of the *T. stangeri* group. The assignation of Haas's variety depends on the interpretation of the amount of crushing by sedimentary load it has suffered. Certainly some crushing is indicated by the buckling of the intercostae near the venter, in line with tubercle positions (Haas, 1942, fig. 12b). If this specimen is greatly crushed, it would be difficult to separate from *T. americanus* (Lasswitz) or from *T. stangeri sparsicosta* (Spath).

Whether Spath's variety *sparsicostus* of *Texanites stangeri* (Baily), for which the estimated measurements are given herein for comparison, can be properly separated from *T. americanus* or not I am not at this writing prepared to say. The costation may be coarser on the Texas individuals and the keel higher on Spath's African species.

In addition to the individuals for which measurements are given, two other specimens are known, one from BEG-98 and another from BEG-19794.

Horizon and localities.—*Texanites americanus* (Lasswitz) occurs with *Inoceramus undulatoplicatus* Römer at New Braunfels where Durham and Stephenson (U. S. G. S. Mesozoic locality 7628; specimen in the U. S. National Museum) have collected individuals of each. This is in formation B. The horizon from which these fossils were collected should be Lower Santonian according to present correlation; UT-563, also assigned to *T. americanus,* is from the top of formation C, also probably Lower Santonian. Two specimens of *T. americanus* are from the top of formation B, Comal County. Another specimen, Lasswitz's, is apparently from formation B, Travis County (capitol excavation).

TEXANITES ROEMERI (Yabe and Shimizu, 1923)

Pl. 43, fig. 1

=*Ammonites texanus* Römer, 1852, pl. 3, figs. 1d, 1e only (not pl. 3, figs. 1a, 1b, 1c)
=*Schloenbachia texana* Lasswitz (*non* Romer), pl. 7, figs. 2ab, p. 30, 31
=*Mortoniceras lasswitzi* Yabe and Shimizu, 1926 (not *Mortoniceras lasswitzi* Yabe and Shimizu, 1923) p. (2)
=*Mortoniceras roemeri* Yabe and Shimizu, 1923, p. 30; in Adkins, 1928, p. 252; in Collignon, 1948, fasc. 13, p. 70 (*25*), text figs. 3, 3ab, 4, fasc. 14, p. 42 (*99*)
=*Mortoniceras texanum* (Lasswitz) in Adkins, 1933, p. 453

Holotype.—Apparently Yabe and Shimizu (1923) meant the original of Römer's (1852) pl. 3, figs. 1d, 1e, to be the type of *Texanites roemeri.* Since Römer's illustrations seem to be a composite drawing from the two individuals illustrated by Collignon (1948, text figs. 3, 3ab, 4), it now seems necessary to designate the original of Collignon's (1948) text figs. 3, 3ab as the holotype. A cast of this fossil is in the collections of the Bureau of Economic Geology.

Specific characters.—Oligogyral, sublatumbilicate, concentrumbilicate, subgradumbilicate, carinate. The whorl section is higher than wide, HF/W ranging around 1.3. Intercostal width greatest just dorsad of mid flank and costal width greatest at the lateral (second) tubercle. Costation is moderate, ranging from 25 to 32 ribs per volution, depending on the individual and the diameter of the conch. At earlier diameters costae range from 15 to 20 per volution. Costae are wider than intercostae at diameters of more than 100 mm.; costae distinctly rounded in section. A few bifurcations occur in the younger stages of WSA–71.

Tuberculation consists of nodate umbilical and lateral tubercles, slightly clavate submarginal tubercles, and clavate marginal and texanitine tubercles. Tuberculation in the juveniles is not known. The aperture is likewise unknown, but Lasswitz has reproduced an excellent suture.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
Lasswitz's pl. 7, figs. 2ab								
135.0	37.5	37.0			29			29
100.0	36.0	42.5			32			32
75.0	38.0	39.5						
60.0	39.0	38.5						
50.0	39.0	38.0						
WSA–71								
225.0	40.0	35.5	29.5	1.20	23			23
200.0	36.0	34.0			22	3		25
150.0	40.0	36.5	28.5	1.33	20	4		24
Measurements of Collignon's (1948) text fig. 4 (cast in Bureau of Economic Geology)								
50.0	38.0	40.0	36.0	1.11	17	.	1	19
40.0	32.5	40.0	39.0	1.03	15		2	19
30.0	30.0	41.5	38.5	1.08				
20.0	26.0	43.5	41.5	1.07				
Measurements of Collignon's (1948) text figs. 3, 3ab (cast in Bureau of Economic Geology)								
80.0	39.0	37.0	34.0	1.09	19			19
60.0	36.0	37.0	36.0	1.03	20			20
40.0	39.0	39.0	39.0	1.00	19	.		19

Remarks.—Yabe and Shimizu (1923) applied *Mortoniceras roemeri* to the original of Römer's (1852) illustrations on pl. 3, figs. 1d and 1e only, not knowing it was a composite drawing from two small fossils. In the same paper they renamed unwarrantedly and without explanation, *Mortoniceras lasswitzi*, for the original of *Schloenbachia quinquenodosa* var. *minuta* of Lasswitz (1904). Yabe and Shimizu (1926) then applied the name *Mortoniceras lasswitzi* to the original of *Schloenbachia texana* (Lasswitz, 1904, *non* Römer, 1852). *Mortoniceras lasswitzi* Yabe and Shimizu, 1926, is a homonym, then, of *M. lasswitzi* Yabe and Shimizu, 1923, which in turn is a synonym of *Texanites minuta* (Lasswitz). The type of *T. minuta* (Lasswitz) is lost and no plastotypes are extant. Lasswitz's figure is not sufficiently good to identify the specimen with any of the Texas specimens. Consequently it seems that the three above names would best be forgotten.

Adkins (1928) considered *Schloenbachia texana* (Lasswitz, *non* Römer) as belonging to the same species as the two small originals of Römer's (1852) pl. 3, figs. 1d, 1e, and used only the name *Texanites roemeri* (Yabe and Shimizu). I believe that Adkins was correct in this interpretation both on morphological and stratigraphical evidence.

WSA–71 is like Lasswitz's illustration of *Texanites roemeri* (Yabe and Shimizu) (Lasswitz, 1904, pl. 7, figs. 2, 2a) in the possession of distinctly club-shaped ribs beyond the 100 mm. diameter, with the ribs widening ventrad. WSA–71 is more densicostate than was Lasswitz's individual, but Lasswitz's illustrator was not always careful in rib counts. Few species of *Texanites* have the club-shaped ribs. WSA–71 has a few bifurcating ribs at younger stages, whereas Lasswitz (1904, pl. 7, fig. 2) shows no bifurcating ribs. However Lasswitz's figures are not always trustworthy, particularly in the earlier whorls (e.g., compare Lasswitz, 1904, pl. 6, fig. 2, illustration of "*Schloenbachia*" *maxima* with the photograph of a cast of the same specimen by Young, 1957, pl. 8, fig. 3).

"*Mortoniceras*" *soutoni* Woods, 1906 (*non* Baily) does not develop the extremely broad ribs in the adult so typical of *T. roemeri*. Woods's specimen is also more evolute, though probably not enough to be significant at a specific level. *Texanites angolanus* Haas (1942), and its variety *berryi*, fall within the range of conch shape of the Texas individuals of *Texanites roemeri*. The ribs on Haas's specimens are a little sharper, and in the larger whorls the ribs do not broaden ventrad as much as do the Texas forms of *T. roemeri*. In *T.*

angolanus and its variety the marginal and submarginal tubercles are closer together than they are in *T. roemeri*.

In addition to the individuals for which measurements are given above, there are two specimens in the Wollman collection, two fragments in The University of Texas, Department of Geology collection, and a questionably assigned specimen in the Bureau of Economic Geology. A tenth individual is in the Adkins collections.

Horizon and locality.—Lasswitz (1904) had two individuals, one from Austin, presumably the capitol excavation, and the other stated to come from Montague County; the latter is obviously an error since the youngest Cretaceous strata in Montague County are Albian. Adkins (1928, p. 231) has pointed to other erroneous locality data for Lasswitz specimens. I have already discussed the site at the excavation for the capitol building at Austin. This site is in formation B, zone of *Inoceramus undulatoplicatus* Römer, and some part of formation B older than the *I. undulatopilcatus* zone. WSA–71 is from the resistant glauconitic sandstone bed (Bed 4 of Stephenson and Monroe, 1940), at Plymouth Bluff, Lowndes County, Mississippi. This is the same horizon from which Stephenson and Monroe (1940) illustrated *Menabites densinodosus* (Renz) [= *Mortoniceras* aff. *M. texanum* (Römer) in Stephenson and Monroe, 1940, pl. 3, fig. 1], and should correlate with the Dessau chalk. Another specimen, WSA–827, is just labeled Lowndes County. The *Placenticeras planum* Hyatt (extremely large, slightly costate forms very unlike the type of the species) that occur with *M. densinodosus* (Renz) and *T. roemeri* (Yabe and Shimizu) at Plymouth Bluff lead me to believe that the horizon is in the Lower Campanian. Further evidence of Lower Campanian age of *T. roemeri* is the collection in 1959 of two individuals from about the middle of the Dessau chalk by Miss Constance Wollman, with *Submortoniceras tequesquitense*, n. sp., *Parapuzosia paulsoni*, n. sp., and *Placenticeras guadalupae* (Römer).

TEXANITES STANGERI (Baily) DENSICOSTUS (Spath, 1921b)

Pl. 42, figs. 3, 4; pl. 43, figs. 2–4; pl. 47, figs. 5, 6; pl. 48, figs. 2, 5, 6; pl. 71, figs. 1–4; text figs. 25cegh, 34c

=*Mortoniceras stangeri* (Baily) var. *densicosta* Spath, 1921a, pl. 23, figs. 3abc, and text fig. 1abc; Spath, 1921b, p. 138–139, pl. 5, fig. 2

Holotype.—The specimen figured by Spath (1921b) on pl. 5, fig. 2.

Specific characters.—Few whorls with very little overlap, widely sublatumbilicate to narrowly latumbilicate, concentrumbilicate, subgradumbilicate, carinate. The whorl section is slightly higher than wide, HF/W ranging from 1.04 to 1.21. The figure of 1.30 in the table is probably on an individual that has been flattened by compaction. The widths on UT–30502 and UT–92 were not measured, these two fossils having obviously been crushed.

The greatest intercostal width is at the lateral tubercle. The greatest costal width is at the umbilical tubercle or the lateral tubercle, depending on whether or not the umbilical tubercle is sufficiently long to extend laterad of the flank tubercle. These width relationships seem to remain constant for the entire ontogeny of the conch.

Costation is moderate, costae and intercostae about equal in width at earlier diameters, intercostae wider than costae at later diameters. The costal width ratio changes at about the 75 mm. diameter on UT–92, at about 85 mm. on BEG–17503, at about 95 mm. on BEG–20282, and at about 120 mm. on UT–30502. The costae are stronger on UT–30502 than on other individuals, and in all individuals the number of costae decreases with increasing diameter, ranging from 32 to 38 at less than 100 mm. diameter to a range of from 27 to 33 at diameters of greater than 100 mm. At diameters greater than 100 mm. ribs are single and primary, only 1 intercalated rib and 1 bifurcating pair being observed on all individuals seen. At the 75 mm. diameter bifurcating pairs may account for a small percentage of the ribs to almost ⅔ of the ribs.

Umbilical and flank tubercles are nodate on all specimens except UT–92. The slight clavateness of these two tubercles on UT–92 probably results from the tubercle on the internal mold being compressed ventrodorsally when the steinkern was flattened with an overlying sedimentary load. The submarginal (third) tubercles are clavate to a diameter of from 80 to 100 mm. after which they are nodate. Marginal (fourth) and external (fifth) tubercles are clavate at all diameters. There are 5 tubercles present at all observable diameters, 20 mm. being about the smallest diameter at which tubercles are preserved. The bifurcating stage of Collignon (1948, p. 56, stage 3), if present, precedes the 40 mm. diameter, and in BEG–17503 precedes the 20 mm. diameter.

Coiling is evolute, and there is very little or no overlap, the marginal tubercles being visible at all observable stages of growth. All individuals are septate throughout, and the body chamber is unknown. The greatest diameter of any septate individual is the 160 mm. diameter of UT–92.

The suture has a typical texanitid external lobe, except for the bifid barroisiceratine flair projecting from the external lobe into the first lateral saddle. The first lateral saddle is unusually wide, with the auxiliary lobe slightly asymmetric dorsad. The first lateral lobe is bifid, about as long as the external lobe, and not equally developed on each side.

Measurements of several individuals are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–92								
160.0	53.0	26.0			29			29
125.0	50.5	28.5			32	1		33
100.0	58.5	27.5						
75.0	53.0	29.5						
60.0	50.0	31.5						
BEG–17503								
75.0	47.5	30.5	28.0	1.09	29		2	33
60.0	50.5	28.5	27.5	1.04	28		2	32
50.0	45.0	29.0						
UT–30502								
156.0	51.5	25.5			27			27
125.0	53.5	24.5			28			28
100.0	53.0	25.5						
75.0	48.0	29.0						
BEG–20282								
100.0	48.0	29.5	25.0	1.18	31		1	33
75.0	47.0	34.5	26.5	1.30	27		10	37
60.0	50.0	33.5	28.5	1.17	28		10	38
50.0	52.0	34.0	28.0	1.21				
40.0	47.5	32.5						
UT–594								
175.0	59.5	26.5	19.5	1.36	26			26
125.0	50.0	26.5	24.5	1.08	25			25
100.0	45.0	27.0	24.5	1.10	26			26
75.0	47.0	31.5	26.5	1.19	26			26
47.5	43.0	31.5	23.0	1.36	28	2		30
30.0	46.5	36.5			24	2		26
20.0	44.0	37.5			25	3		28
15.0	43.5	40.0						
WSA–49								
150.0	50.0	28.5	25.5	1.14	29			29
125.0	51.0	28.5	25.5	1.14	29			29
100.0	46.0	26.5	25.0	1.06	28			28
75.0		29.5	24.0	1.23	28			28
50.0	46.0	31.0	27.0	1.14	29			29
30.0	45.0	31.5	33.0	0.96	28			28
20.0	40.0	32.5						
WSA–96								
125.0	46.5	33 5	25.0	1.34	26			26
100.0	46.0	32.0	26.0	1.23	27			27
75.0	46.0	30.5	27.5	1.11	28			28
50.0	47.0	32.0			24		3	30
Texanites stangeri densicostus (Spath, 1921b, pl. 5, fig. 2) for comparison (measurements estimated from Spath's illustration)								
120.0	54.5	27.5			26		1	28
100.0	49.5	28 5			23		2	27
75.0	50.0	28.5			18		4	26
60.0	46.0	30.0			18		4	26
50.0	43.5	32.0			20		3	26
40.0	43.5	35.0			9		11	31
30.0	45 0	40.0			8		13	34
20.0	45.0	37.5			8		12	32

Remarks.—*Texanites stangeri densicostus* (Spath) forms a group of evolute texanitines so far known only from Texas and South Africa. Another species, almost as evolute, is *Texanites americanus* (Lasswitz). The group of *Texanites* which Collignon (1948) places around *Texanites texanus* (Römer) is probably the next most evolute. As illustrated in text fig. 18 (p. 243), there is a decrease in the diameter of the umbilicus and an increase in whorl height with decrease in age from one species to another.

From figures given by Collignon (1948,

p. 65) in *T. texanus* s. l. U ranges from 36.0 to 51.0 (averaging about 44.0), the holotype being intermediate in the grouping. In synonymy he includes the 2 juvenile individuals here assigned to *Texanites roemeri* (Yabe and Shimizu). *Texanites texanus* (Römer) is much more coarsely costate in the juvenile than is *T. strangeri densicostus.* U in *T. strangeri densicostus* ranges from 40.0 to 59.0 (averaging around 50.0), which is more evolute than *Texanites texanus.* If all of the individuals are not crushed, HF/W in *T. texanus* is much greater at the large diameters than it is in *T. stangeri densicostus. T. stangeri* is also much more evolute than the species of *Texanites* described by Collignon (1948) and is more evolute and has a lower height-width ratio than either *Texanites roemeri* (Yabe and Shimizu), *T. lonsdalei*, n. sp., or *T. shiloensis*, n. sp. *T. stangeri sparsicostus* (Spath, 1921b) is more coarsely costate and more like *T. americanus* than like *T. stangeri densicostus. T. quinquenodosus* var. *evoluta* Haas is much like *T. stangeri densicostus*, but becomes, in the adult, coarse-ribbed as in *T. americanus.*

Text fig. 19 (p. 247) illustrates scatter plots for several features of *Texanites stangeri densicostus.* The plots are of ontogenies; the circles represent Texas forms and the dots represent Spath's holotype. For the characters plotted the South African holotype falls well within the range of variation of the Texas individuals. About 25 Texas specimens are known to the writer, and there are probably additional specimens in the Adkins collections.

Horizon and localities.—*Texanites stangeri densicostus* (Spath) in Texas is known from formation B. It occupies a position below *Texanites texanus texanus* in the lower part of the zone of *Inoceramus undulatoplicatus.* It occurs above the zone of *Prionocycloceras gabrielense*, n. sp., and *Protexanites planatus* (Lasswitz). The individuals known to me are all from Travis and Williamson Counties, Texas; in all there are about 25. An individual more closely resembling *Texanites stangeri stangeri* was collected by Moon (1953) from near the top of the Fizzle Flat lentil of the Terlingua formation. It occurs below the *Inoceramus undulatoplicatus* zone in Brewster County. Another individual (UT–30723) was collected from the *I. undulatoplicatus* zone of the Terlingua formation on Fizzle Creek, Agua Fria Quadrangle, Brewster County, Texas.

TEXANITES STANGERI (Baily)

Pl. 45, figs. 1–3; text fig. 25p

=*Ammonites stangeri* Baily, 1855, p. 455–456, pl. 11, figs. 2ab

=*Mortoniceras stangeri* (Baily) in Woods, 1906, p. 338, pl. 44, figs. 1ab; Spath, 1921b, p. 137–138, pl. 9, fig. 2

Measurements of three specimens follow. The measurements of Woods's (1906) and Spath's (1921) specimens are estimated from their illustrations.

D	U	HF	W	HF/W	P	S	B	T
From Woods, 1906, pl. 44, fig. 1a								
160.0	57.0	26.5			22	11		33
125.0	51.5	26.0			18	13		31
100.0	50.0	28.5			16	14		30
75.0	48.0	30.0			17	12		29
50.0	46.0	31.0						
From Spath, 1921b, pl. 9, fig. 2								
300.0	51.5	29.0			39			39
250.0	54.0	27.0			37			37
200.0	54.0	28.5			32			32
150.0	53.5	29.0			28		1	30
100.0	49.5	33.5			20		3	26
50.0	53.0	35.0						
WSA–92								
215.0	53.5	26.0	21.0	1.24	32	5		37
200.0	52.0	25.0	20.5	1.22	28	5		33
150.0	52.5	27.0	22.5	1.20	22	5		27
125.0	51.0	25.5	23.0	1.11	15		4	23
100.0	52.0	28.0			14		5	24
75.0	46.0	32.0			11		7	25
50.0	46.0	37.0			12		6	24
30.0	47.0	33.5			19			19
20.0	52.5	42.5			18			18

Remarks.—This species is not being described in this work, nor do I know of any examples of *Texanites stangeri stangeri* (Baily) from the Gulf Coast, only the questionable form from the Agua Fria Quadrangle discussed previously. For comparative purposes WSA–92 is illustrated. I would like to emphasize the variation in type of ribbing from single and primary to primary and intercalated to primary and bifurcating. There is great variation from one specimen to the next, and from one ontogenetic stage to the next on the same individual.

Horizon and locality.—WSA–92 is Lower Santonian, from the Umkwelane River, Natal.

TEXANITES SHILOENSIS, n. sp.

Pl. 46, figs. 1–4; pl 54, figs 4–7; pl. 70, figs. 5, 6, 8; text fig. 24d

=*Texanites internodosus* Young and Marks 1952, pp. 477, 478, 480, 482, 483, 485 (not *T. internodosus* Renz in Young and Marks, 1952, pl. 1, fig. 4)

Holotype.—UT–1986, from the Dessau limestone, Brushy Creek, 2 miles south of Hutto, Williamson County, Texas, upstream from the Shilo schoolhouse.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, widely subangustumbilicate to narrowly sublatumbilicate (U from 30.0 to 42.0), carinatitabulate, whorl section higher than wide (HF/W from 1.28 to 1.51) increasing with size. The greatest costal and intercostal widths both remain at the lateral (second) tubercle throughout the ontogeny, resulting in arched flanks and a suboval whorl section.

Costation is moderate to dense, and variable, ranging from 24 to 45 or more ribs per volution, but varying only by 8 or 10 ribs at any one diameter. Intercostae are from ½ to ⅔ the width of the costae at diameters greater than 70 mm. Costae are prosiradiate, more strongly so when preceded by intercalations or bifurcations. Intercalations are many from diameters of 70 to 150 mm., and one-half of the costae or more may be intercalated at these diameters. However, at diameters of 40 mm. and less there are only 7 to 8 intercalations per volution, and beyond a 200 mm. diameter there may or may not be intercalations, but usually not more than 6 per volution.

The pentatuberculate stage is persistent at all stages beyond the 40 mm. diameter, but there is a smooth stage which persists to about a 9 mm. diameter. The umbilical tubercle appears at about a diameter of 14 mm., and the first half of the flank is smooth preceding the 14 mm. diameter, the umbical tubercles and entire costae appearing at the same diameter. The external (fifth), marginal, and submarginal tubercles are present preceding the 20 mm. diameter, and the costae are present on the outer half of the flank preceding the 14 mm. diameter, and presumably the three outer tubercles are present at this diameter also, but this part of the conch has not been seen at the 14 mm. diameter. The lateral (second) tubercle appears at about the 35 mm. diameter on the juvenile specimen studied. Preservation of juvenile specimens was not good enough to study the variation of the very early whorls; however, enough was observed to indicate approximately the size of the conch at which tubercles and costae appear. Umbilical tubercles are bullate at the earliest diameters, the lateral and submarginal are nodate, and the marginal and external are clavate. At greater diameters the umbilical tubercles remain bullate, the lateral become slightly bullate, the submarginal are nodate, bullate, or clavate, and the marginal and external remain clavate, although the marginal tubercles are not strongly clavate. Although persistent throughout the ontogeny, the lateral, submarginal and marginal tubercles are very weak beyond the 100 mm. diameter.

Overlap is to just dorsad of the submarginal tubercle at diameters of less than 200 mm. At greater diameters the submarginal tubercle is visible.

UT–25 and UT–1696 are septate throughout, as are all of the many fragments, but on UT–1986 septation ceases at the 306 mm. diameter. Beyond this about 100° of the body chamber, a little less than ⅓ of a volution, is preserved. No more can be said about the size of the species, but this part of the body chamber of UT–1986 does not have the gerontic ribbing of most texanitine adult body chambers.

Measurements of several individuals are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–1986 (holotype)								
375.0	41.5				37	1	.	38
275.0	40.0	32.0			31	.		31
UT–1696								
200.0	32.5	37.0	24.5	1.51	32	6		38
150.0	35.0	41.0	27.5	1.49				
120.0					30	11		41
100.0	40.0	42.0	31.0	1.35				
UT–15								
100.0	30.0	42.0	31.0	1.35	22	27		49
75.0	30.5	43.5	32.0	1.36				
60.0	33.5	45.0	32.0	1.40				
UT–25								
40.0	37.5	38.5	27.5	1.40	29	8		37
30.0	35.0	38.5	30.0	1.28	22	7		29
20.0	35.0	45.0	30.0	1.50				
WSA–18								
200.0	38.0	37.5			27			27
WSA–31								
390 0	42.0	32.5			31			31
300.0	40.0	37.5			27			27
200.0	35.5	38.5			24			24

Remarks.—A great many individuals of *Texanites shiloensis,* n. sp., are in the collections, but most are poorly preserved, or are distorted by sedimentary processes, so that measurements are difficult to obtain and cannot be trusted. This species has more intercalations than most species of *Texanites,* and in this feature differs from *T. quinquenodosus* (Redtenbacher), which it otherwise resembles in costation. Also *T. shiloensis,* n. sp., is more involute than *T. quinquenodosus,* and in *T. shiloensis* the umbilical tubercle hangs over the umbilical wall, as in many later species of *Submortoniceras.* Actually this species is placed in *Texanites* rather than in *Submortoniceras* because of the pentatuberculate condition and the arched flanks. *T. shiloensis* is more involute than most species of *Texanites* and in this way is also transitional to species of *Submortoniceras,* particularly those species closely related to *S. tenuicostulatum* Collignon (1948). These species related to *S. tenuicostulatum* have flat flanks and develop the typical whorl section of submortonicerines; they also develop more fully the bifurcations and the intercalations.

The more flat sided, densely costate individuals of the *T. shiloensis* "biospecies" could be considered to be the lowest occurrence of the *S. tequesquitense,* n. sp., chronospecies, if such terms were being used. In other words *Texanites shiloensis* in the basal Dessau limestone seems to grade upward into *Submortoniceras tequesquitense* in the middle and upper Dessau limestone. Already in *Texanites shiloensis* there appear forms that could be placed in *Submortoniceras tequesquitense* on morphology alone, although they are no more than the flat-flanked, more densicostate forms of *T. shiloensis.* However, higher in the Dessau limestone, when the gradation to *Submortoniceras tequesquitense* is complete, there are none of the arched-flank, more sparsicostate forms that would normally be assigned to *T. shiloensis.* In The University of Texas collections there are about 14 good specimens besides those for which measurements are given.

Horizon and localities.—*Texanites shiloensis,* n. sp., occurs in the lower part of the Dessau limestone. It is known from Williamson, Hays, Travis, and Kinney Counties, Texas, in this formation. It is the most abundant ammonite in the Austin group in Central Texas. Additional individuals are known from the San Carlos formation, Presidio County, and from Arroyo Tecolote, Coahuila. In the U. S. National Museum *Texanites shiloensis* is in the following collections: U. S. G. S. Mesozoic locality 282, being part of the 1882 collection of L. C. Johnson, from Lowndes County, Mississippi; U. S. G. S. Mesozoic locality 6925, on the Tombigbee River, from the bluff below Aberdeen, Mississippi; and U. S. G. S. Mesozoic localities 8230 and 10852, Tequesquite Creek, Kinney County, Texas.

TEXANITES LONSDALEI, n. sp.

Pl. 34, fig. 1; pl. 51, figs. 3–7; pl. 58, figs. 5, 6; text figs. 22ad

=*Texanites* cf. *soutoni* (Baily) in Collignon, 1948, p. 78, pl. 9 (3), figs. 1, 1a

Holotype.—UT–30474, from the Dessau chalk, Kitchens Ranch, south of Austin, Travis County, Texas; collector, M. R. Kitchens.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, widely subangustumbilicate to narrowly sublatumbilicate, carinate; whorl section higher than wide, HF/W ranging from 1.5 to 2.0. The higher figures may result from compaction of sediments, Collignon [(1948), pl. 9 (3), figs. 1, 1a], giving an HF/W of only 1.23 at the 100 mm. diameter. The greatest intercostal width up to a diameter of approximately 200 mm. is at the lateral (second) tubercle, migrating ventrad to the mid flank tubercle until it disappears at about a 350 mm. diameter, after which it is at the submarginal (third) tubercle. Costation is moderate, increasing from 27 more or less ribs at the 100 mm. diameter to 30 more or less ribs at the 370 mm. diameter. Most ribs are low, evenly rounded in transverse section, slightly prosiradiate, slightly concave. Up to about a 75 mm. diameter the intercostae are ½ to ⅔ the width of the costae, but beyond the 75 mm. diameter the intercostae are about equal in width to the costae, and on the last whorl even become wider than the costate.

From the earliest observable diameter (about 30 mm.) there are 5 tubercles, which remain consistent in shape and spacing through most of the ontogeny. The external (fifth) tubercle is strongly clavate, the marginal (fourth) and submarginal (third) are clavate, the submarginal only slightly so, the lateral (second) tubercle is nodate, and the umbilical tubercle is bullate. Up to about a 50 mm. diameter the submarginal tubercle is weakly developed, but after that diameter all tubercles are about equal and prominent until about a diameter of 350 mm. where the lateral (second) tubercle is effaced and remains absent for the remainder of the conch.

Overlap covers the marginal tubercle at diameters of less than 35 mm. At greater diameters overlap is exactly to the submarginal tubercle. The mold is septate to 350 mm. diameter, but only a fragment of the body chamber is present. It should be pointed out that the lateral tubercle is effaced only on the body chamber, not on the phragmacone. Although this was a large conch, there is no crowding of the last septa to indicate maturity, only the effacement of the lateral tubercle.

Measurements of UT–30474 are as follows:

D	U	HF	W	HF/W	P	S	B	T
370.0	35.0	35.0	20.0	1.75	28		1	30
300.0	41.5	39.5	19.5	2.01	27		1	29
250.0	34.0	43.5	20.5	2.06	27		1	29
175.0	33.5	40.5	23.5	1.70	24		2	28
125.0	32.0	37.5	25.0	1.50	20		3	26
100.0	34.5	37.0	20.0	1.85	19		4	27

Remarks.—*Texanites lonsdalei*, n. sp., looks much like *T.* sp. aff. *soutoni* Collignon, except that Collignon's specimen does not have as high a whorl as UT–30474, but the Texas specimen may be crushed. Although Collignon (1948) interpreted "*Ammonites*" *soutoni* Baily as a *Texanites*, I am inclined to agree with Spath (1953) that Baily's species is a *Submortoniceras* because of its general similarity to a species with which I am familiar, *S. candelariae*, n. sp., except that *S. candelariae* has less robust ornamentation on the phragmacone. Collignon's specimen (1948, pl. 9(3), figs. 1, 1a) does not belong to Baily's species and is a *Texanites*; the rib morphology compares very favorably with the specimen here described as *T. lonsdalei.*

I am not entirely satisfied with the taxonomic structure of *T. lonsdalei*, n. sp. There are only one specimen and one questionable specimen of *T. lonsdalei* known to me. Seven individuals of *T. roemeri* (Yabe and Shimizu) are known to me, but one of these only by Lasswitz's (1904) illustration. *T. roemeri* (Yabe and Shimizu) differs from *T. lonsdalei* in the development of its extremely broad ribs in the adults. In addition *T. lonsdalei* has a much greater spacing between the external (texanitine) clavae and the marginal clavae. The sutures of "*Mortoniceras*" *soutoni* (Woods, 1906, *non Baily*), *T. lonsdalei*, and *T. roemeri* are markably similar, the greatest difference being the length of minor elements in *T. roemeri,* probably the result of better preservation of the steinkern. Lasswitz's pl. 7, fig. 2b (1904) is misleading, because it has been drawn from the illustration instead of the fossil. Consequently the ventral half of the first lateral saddle is fore-shortened because of faulty perspective, and if drawn properly, would be wider than the dorsal half. The similarity of these sutures may indicate that Woods's specimen, *T. lonsdalei,* and *T. roemeri* are all closely related and also close to the *Submortoniceras-Texanites* taxonomic boundary, for the suture of *Submortoniceras soutoni* (Baily) is not greatly different from the above three species. *Texanites lonsdalei* and probably *T. roemeri* are lowest Campanian. I cannot satisfy myself, from the literature, as to the age of *S. soutoni* (Baily), but it appears to be higher in the Lower Campanian.

Horizon and localities.—*Texanites lonsdalei,* n. sp., was collected by Malcom Kitchens on the Kitchens Ranch south of Austin. It is from the Dessau limestone, about 1 mile east of the San Antonio Highway (81), Travis County, Texas. There is a similar specimen in the U. S. National Museum, in the Johnson collection, Lowndes County, Mississippi, U. S. G. S. Mesozoic locality 282.

TEXANITES, sp. indet., monstrosity

Pl. 50, figs. 1–5

Remarks.—UT–108 is illustrated only because it is interpreted as a monstrosity. From associated forms it appears to be a juvenile *Texanites,* but no adult species of *Texanites* have been obtained from this level which can be identified with it. It is very similar to *Texanites texanus* (Grossouvre, *non* Römer) (Grossouvre's 1894 pl. 16, figs. 2, 3ab, 4ab), which Collignon (1948) refers to *Texanites texanus* (Römer) var. *gallica* Collignon. The individual illustrated in the present work appears, however, to be associated with lowermost Campanian fossils. It is illustrated because, although the right side has the normal 5 tubercles of a true texanitine, the left side possesses only 4 tubercles, and the keel is correspondingly displaced to the left. This individual is probably a true monstrosity.

Horizon and locality.—Dessau formation, about 50 feet above the base, Brushy Creek, Williamson County, zone of *Submortoniceras tequesquitense.*

Genus REGINAITES Reyment, 1957

REGINAITES DURHAMI, n. sp.

Pl. 39, fig. 2; pl. 49, figs. 1, 2, 4; text figs. 22bc

Holotype.—WSA–221, from bed *j* of Durham's (MS) section on Tequesquite Creek, from 14½ feet above the base of the *Pycnodonte aucella* bed, 100 yards below U. S. Highway 90, Tequesquite Creek, Kinney County, Texas. Collected by C. O. Durham.

Specific characters.—Polygyral, concentrumbilicate, subgradumbilicate, widely sublatumbilicate to narrowly latumbilicate (U from 49.5 to 55.0), tricarinate. The whorl section is higher than wide (HF/W from 1.05 to 1.25, with the higher figures representing greater diameters). The costal section is roughly rectangular, the intercostal section more oval. The greatest costal width is at the umbilical tubercle and the greatest intercostal width is just dorsad of mid flank at the 100 mm. diameter, migrating to mid flank at greater diameters.

Costation is moderately strong and moderate in density at diameters of 150 mm. and less, but at greater diameters, although remaining of moderate density, the costae become very weak. Costae are slightly prosiradiate and slightly concave, becoming markedly prosiradiate and concave on the last ⅓ of the body chamber. The costae are single and primary prior to the 150 mm. diameter and beyond the 75 mm. diameter, and about 27 per whorl on the holotype. Beyond the 150 mm. diameter there are about 25 primary costae per volution and in addition there may be from 2 to 4 intercalated costae per volution; all costae terminate with the marginal tubercle.

Tuberculation consists of four (numbers 1, 2, 3, and 4 of the Collignon classification) tubercles, the umbilical, flank, and submarginal being nodate, the marginal being clavate. The flank tubercle is weaker than the others, although prominent. All four tubercles are prominent prior to diameters of 150 mm., but beyond that diameter the umbilical, lateral, and submarginal tubercles become weaker, and by the 190 mm. diameter the lateral tubercle has disappeared. The marginal clavae remain strong until about a 200 mm. diameter after which they also become weak, but only the lateral is lost entirely. The peroniceratine tricarinate venter is retained to the end of the conch, but in the earlier whorls is undulating, indicating the presence of long texanitine clavae.

Overlap does not cover the marginal tubercle. On the holotype the maximum preserved diameter is a little more than 250 mm., and this is very near the orad end of the body chamber. The apertural margin is not preserved and a suture could not be recovered.

Measurements of the holotype (WSA-221) are as follows:

D	U	HF	W	HF/W	P	S	B	T
250 0	52.0	25.0	20.0	1 25	25	4		29
190 0	49.5	25.5	20.5	1.24	25	2		27
150.0	51.0	26.5	24.5	1.08	27			27
100.0	55 0	32.0	29 0	1.10				

Remarks.—The holotype, and one other individual, too badly preserved to add any information to the above description, are the only individuals of *Reginaites durhami*, n. sp., known. Were it not for the unusual position, taxonomically, of these fossils it is doubtful if they would be described. When I first studied the specimen (WSA-221) I thought that I had the connection between *Reginaites leei* (Reeside, 1927a) and *Texanites stangeri* (Baily), and the overall morphology, except for the tricarinate venter of *R. durhami*, is remarkably like that of *T. stangeri*. However, *Texanites stangeri* occurs at a lower horizon than the Lower Campanian horizon of *Reginaites leei*, and the lowest Campanian of *R. durhami*. Furthermore, Woods (1906) points to the *Peroniceras*-like young of *Texanites stangeri*, whereas the cycle is just reversed in *R. durhami*, with the *Texanites stangeri*-like young and the *Peroniceras*-like adult. For this reason I am putting *Reginaites* Reyment, 1957, in the Texanitinae as part of a *Texanites* lineage. Whether this is a correct interpretation of Reyment's genus *Reginaites* I am not certain. Reyment (1957) placed *Peroniceras leei* in *Reginaites*, and *Reginaites leei* is a Lower Campanian fossil, occurring with *Eutrephoceras alcesence* Reeside, *Baculites ovatus* Say, *B. ovatus haresi* Reeside, *Scaphites hippocrepis crassus* Reeside, *S. leei* Reeside, *Placenticerus meeki* Böhm, *P. planum* Hyatt, *Stantonoceras guadalupae* (Römer), *S. newberryi* (Hyatt), *S. sancarlosense* (Hyatt), *S. sancarlosense pseudosyrtale* (Hyatt), and *Texanites omeraensis* (Reeside). This is certainly a Lower Campanian fauna, and can be duplicated in the San Carlos area, except *Pseudoschloenbachia chispaensis* Adkins will be added and *Texanites omeraensis* (Reeside) and *Reginates leei* (Reeside) will be missing. In other words the assemblage collected by Lee from the Omera Mine, New Mexico, and described by Reeside (1927a) is a natural assemblage. Many of the above species also occur in the Dessau limestone from which *R. durhami* was collected, but they have not been collected from the same bed and locality as *R. durhami*. *Reginaites durhami* differs from *R. leei* (Reeside) and *R. quadrituberculatum* Reyment in the presence of texanitine tuberculation in the juvenile whorls. Just to emphasize that the return to a peronicerine venter is not so unusual, *Submortoniceras mariscalense*, n. sp., (pl. 60, figs, 1, 4–6) is also tricarinate, but in an entirely different lineage from *Reginaites*.

Horizon and locality.—The only horizon and locality are those for the holotype: base of Lower Campanian.

Genus BEVAHITES Collignon, 1948

BEVAHITES BEVAHENSIS Collingnon, 1948

Pl. 53, figs. 1–7; text figs. 15c, 21d, 27b

=*Mortoniceras* sp. Adkins, 1928, pl. 34, fig. 1

=*Bevahites bevahensis* Collignon, 1948, pl. 11 (5), figs. 3, 3ab, fasc. 13, pp. 84–85 (*39–40*)

=*Texanites densinodosus* Young and Marks, 1952, pp. 480, 482, 483, only, not Young and Marks, 1952, pl. 1, fig. 1

Holotype.—Presumably the individual represented by figures 3, 3ab of pl. 11 (5) in Collignon (1948); Upper Santonian or basal Campanian.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, narrowly sublatumbilicate to just within the uppermost range of subangustumbilicate (U from 32.0 to 46.5, the larger figures being slightly increased by flattening by sedimentary load), carinatisubtabulate. The whorl section is higher than wide, HF/W increasing with age (HF/W from 0.87 to 1.53). The intercostal section is quadrate at younger diameters, becoming ovoid at greater diameters, the greatest intercostal width ranging from just dorsad of the lateral tubercle to the lateral tubercle at diameters of 100 mm. or less, migrating to mid flank between the lateral and submarginal tubercles at the 200 mm. diameter. The greatest costal width is at the lateral tubercle throughout the ontogeny.

Costation is moderate, becoming dense only at the greatest diameters. There are 24 to 26 ribs per volution at diameters of less than 75 mm. At diameters of from 75 to 150 mm. there are 28 to 34 costae, and at greater diameters from 31 to 37 costae. There are usually 1 or 2 pairs of bifurcating costae per volution at all diameters. Costae are rectiradiate to a 125 or 150 mm. diameter after which they may be rectiradiate if apicad of a bifurcation and prosiradiate if orad of a bifurcation. Costae are wider than intercostae preceding a diameter of about 100 mm., after which costae and intercostae are about the same width. Costae widen somewhat ventrad, as do the intercostae.

The pentatuberculate stage is complete at a diameter of 30 to 38 mm., the lateral tubercle appearing at about the 20 mm. diameter on BEG–20281 and prior to the 22 mm. diameter on UT–30511. On UT–30511 the submarginal tubercle splits off from the marginal at about a 33 mm. diameter and at about the 27 mm. diameter on BEG–20281. This is a definite bevahitine derivation, and the marginal and submarginal tubercles then remain close together on a raised swelling to diameters of 100 mm. or more, and still remain close together without the raised swelling to diameters of 200 mm. or more.

The umbilical and lateral tubercles are nodate at earlier diameters, both becoming bullate at about the 150 mm. diameter. The submarginal tubercle varies considerably, being clavate shortly after appearance, then being nodate to diameters of between 50 and 100 mm., becoming slightly clavate for ¼ or ½ volution before becoming nodate on or near the body chamber. The marginal and external tubercles are clavate, the external clavae being especially long throughout the ontogeny.

Those individuals with wider umbilici overlap to the marginal clavae, and those individuals or stages with narrower umbilici overlap to partially cover the marginal clavae. Parts of UT–201 appear to be body chamber, but the exact position at which septation ceases cannot be determined. Aperture and suture have not yet been recovered.

Measurements of several individuals are as follows:

D	U	HF	W	HF/W	P	S	B	T
BEG-20281								
60.0	43.5	34.0	31.0	1.10	26			26
40.0	41.5	32.5	35.0	0.93	24			24
30.0	46.5	33.5	38.5	0.87	20			20
UT–201								
225.0	46.0	36.5			32		1	34
200.0	46.5	30.0			31		1	33
175.0	45.0	31.5			29		1	31
150.0	40.5	30.0			29		1	31
125.0	41.5	31.0			29		1	31
100.0	44.0	33.0			28		1	30
75.0	38.5	32.0			29		2	33
50.0	44.0	40.0						
UT–30511								
220.0	38.0	33.0	21.5	1.53	33		2	37

D	U	HF	W	HF/W	P	S	B	T
150.0	39.0	33.5	24.5	1.37	30		2	34
105.0	34.6	33.0	26.5	1.25	25		2	29
75.0	35.0	37.5		..	24		2	28
50.0	32.0	33.0						

Remarks.—Bevahites bevahensis Collignon is a fairly distinctive group. The entire group differs from *Texanites* in the obvious derivation of the bevahitine submarginal and marginal tubercles. This species belongs to the transitional group of Collignon (1948), group of *Bevahites bevahensis*, which Collignon considers, with some doubt, to be Upper Santonian.

The Texas individuals differ little from Collignon's (1948) illustrated forms, having the same range in HF/W, and U, at comparable diameters. The external tubercles may be a little longer in the Texas forms than on Collignon's individual, and there are one or two less bifurcations per volution on the Texas individuals. The appearance, arrangement, and derivation of the different tubercles in the early whorls seem to agree well with Collignon's form. The greatest drawback in making the Texas and Madagascar forms conspecific is that Collignon had no complete individuals, and none even of the magnitude of UT–30511, UT–201, or the individual illustrated by Adkins (1928, fig. 1, pl. 34), the latter being over 300 mm. in diameter. This results in a comparison of the juvenile stages only, never a completely satisfactory procedure. The tubercles on the Madagascar forms are a little sharper than on the Texas forms, but they are probably not eroded as much. The flanks of the Texas forms appear to be as flat as on the Madagascar individual; Collignon (1948) emphasizes this feature. The importance of the bevahitine stage of tubercle derivation is still uncertain, since it may be found on some species, sometimes transient, often more enduring, of *Delawarella* and *Submortoniceras*. On species of these genera the bevahitine derivation has not been observed, the marginal and submarginal tubercles arising independently, but they are frequently much closer together than are any other pair of tubercles.

In addition to the 3 individuals for which measurements are given above, the following incomplete individuals can be assigned to *Bevahites bevahensis* Collignon: UT–1608, and questionably assigned are UT–29 and UT–30695. Specimens in the U. S. National Museum from U. S. G. S. Mesozoic localities 282, 7599, and 10852 can also be assigned to *B. bevahensis* Collignon. UT–23 is an individual from a higher horizon, but still below the zone of *Delawarella delawarensis,* which seems to be intermediate between *B. bevahensis* and the finer-ribbed individuals of *D. delawarensis;* this individual is a juvenile and definite assignment must be reserved.

Lasswitz's illustration of "*Schloenbachia*" *quinquenodosa* var. *minuta* (1904, pl. 8, fig. 4) shows a bevahitine tubercle to a diameter of almost 100 mm. Having had the opportunity to compare casts with other of Lasswitz's illustrations, I had originally assumed the drawing to be faulty. However, the bevahitine tubercle is not common in Texas ammonites, and it is difficult to understand where the artist would get the idea to produce such a faulty drawing. Lasswitz's drawing may be correct in the bevahitine tubercles and the ribs and other tubercles poorly illustrated. Lasswitz's (1904, pl. 8, fig. 4) is most likely a *Bevahites bevahensis*, but neither specimen nor casts are extant. Adkins (labels in the Bureau of Economic Geology collection) had identified specimens which I have here referred to *B. bevahensis* Collignon as "*Texanites minutus* (Lasswitz)." Whether he had seen the holotype, or was making his identification by comparing with Lasswitz's illustration I do not know. Because the holotype of *Texanites minutus* is lost and there are no casts extant, and because Lasswitz's illustrations are often faulty, I have used Collignon's name *B. bevahensis.*

Horizon and localities.—Bevahites bevahensis, in the Gulf Coast, occurs concentrated in the base of the Dessau chalk on Brushy Creek, southern Williamson County, where it occurs with *Texanites shiloensis*, n. sp. It is also known from the base of the Dessau chalk at South Doır's Creek, Bell County, Walnut Creek, Travis County, and Tequesquite Creek, Kinney County, Texas. Specimens in the U. S. National Museum may be found in collections from U. S. G. S. Mesozoic localities 10852 (Tequesquite Creek), 7599 (Walnut Creek), and 282 (the L. C. Johnson collection from Lowndes County, Mississippi). Rarely individuals may be found as high as 60 feet into the Dessau chalk, where they are associated with *Submortoniceras tequesquitense*, n. sp., and are apparently Lower Campanian. The basal Dessau chalk I am calling Upper Santonian.

BEVAHITES COSTATUS Collignon, 1948, subsp. COAHUILAENSIS, n. subsp.

Pl. 47, figs. 1–4; pl. 71, fig. 5; text fig. 34b

Holotype.—BEG–20288, from the *Exogyra tigrina* zone, Lower Campanian, Arroyo Tecolote, near Jiménez, Coahuila, Mexico.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, narrowly sublatumbilicate, arched intercostally, carinate. The whorl section is higher than wide at all observable diameters, HF/W from 1.20 to 1.35. The greatest intercostal width is at the lateral tubercle. The intercostal section is subcircular at a diameter of 50 mm., becoming oval and higher with increase in size.

Costation is moderate to dense, there being in the neighborhood of 28 primary costae at the diameter of 75 mm., decreasing to 23 primary costae at a diameter of 150 mm. However, costation increases, there being only about 3 intercalations at the earlier diameter (75 mm.), and the number of intercalations increases to 15 or so in the adults, resulting in a total increase in costae of from around 30 per volution at a diameter of 75 mm. to slightly less than 40 ribs per volution at the 150 mm. diameter. Costae are wider than intercostae, but this width difference appears greatest at earlier diameters.

The earliest tuberculation is obscured as a result of poor preservation, but at a diameter of 50 mm. the pentatuberculate stage shows a definite bevahitine relationship of the third and fourth tubercles on a raised platform on the rib, and close together. This bevahitine condition persists beyond the 100 mm. diameter and is faintly present even at the 150 mm. diameter. The umbilical tubercle is nodate to slightly bullate throughout, and the lateral tubercle is nodate in the early whorls, up to the 40 mm. diameter, becoming slightly bullate beyond that diameter. The marginal and submarginal tubercles are clavate up to the 75 mm. diameter, the submarginal tubercle becoming nodate as it becomes separated from the marginal, the marginal tubercle remaining clavate throughout. The external clavae are small, neat, and evenly spaced. A number of 40 seems to persist for the external clavae per whorl, whether there are only 32 ribs per whorl, or 38. The external clavae are a part of and terminate the ribs, except for the intercalated ribs; the intercalated external clavae have very short ribs intercalated ventrad of the marginal row of tubercles.

Overlap is to just ventrad of the marginal row of tubercles, the marginal tubercles being visible on the inner whorls. BEG–20288 is septate throughout; aperture and suture are irrecoverable.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
BEG–20288								
147.0	36.5	37.5	25.5	1.36	23	15±		38±
100.0	35 5							
75.0	36.0	32.0	26.5	1.25	28	3±		31
50.0	41.0	36 0						

Remarks.—*Bevahites costatus* Collignon (1948) belongs to the species group of *B. subquadratus* Collignon, containing *B. subquadratus*, *B. romani* Collignon, *B. bidichotomous* Collignon, and *B. costatus*. Of the latter species Collignon (1948) described the mutations (in the sense of Waagen, not DeVries) *costatus*, s.s., *crassicostata*, *rarecostata*, *costulata* and *inornata*. The Coahuila form which I have described as a subspecies so that the name may be valid, differs from *Bevahites costa-*

tus costatus in no greater or different degree than do Collignon's "mutations."

Bevahites costatus coahuilaensis, n. subsp., differs from *B. costatus costatus* in the slighter whorl height and greater umbilical diameter, the total variation of both being well within the variation of most texanitine species. There are a few more intercalated ribs in *B. costatus coahuilaensis* than in *B. costatus costatus*, but not as many as in *B. costatus costulata*, the latter having more sinuous and a greater number of costae. The ornamentation of *B. costatus inornata* is reduced more than in the subspecies bearing other names. *B. costatus coahuilaensis* does not have the coarser costae of *B. costatus crassicostata*, and most closely corresponds to Collignon's (1948) *B. costatus rarecostata*, with which it agrees in nearly all respects except *B. costatus rarecostata* has a few bifurcations at the umbilical tubercle which are absent in *B. costatus coahuilaensis*, n. subsp.

There are a number of individuals from the lower Burditt marl in the Pilot Knob area of Travis County which are too poorly preserved to be identifiable, even to genus. They have the general form of *Bevahites costatus*, s. l. They also have the general form of *Menabites belli*, n. sp., which occurs with them. Supposedly these poorly preserved individuals are *M. belli*.

Below this group of fossils, in the upper Dessau formation of the same area, between the *Gryphaea aucella* beds and the *Exogyra laeviuscula–E. tigrina* epibole (lumachelle), occurs another bunch of similarly shaped texanitines. All of these, so far, are so poorly preserved as to be also generically unidentifiable; whether they belong to *Memabites belli*, n. sp., or *Bevahites costatus* cannot be determined.

Carbonate rock internal molds of fossils are usually poorly preserved. The fossils in the Pilot Knob area, Dessau and Burditt formations, are more poorly preserved than most because the carbonate rocks are arenites and contain a high percentage of fragments of altered pyroclastic rocks now approaching a nontronite clay in composition (Weiss and Clabaugh, 1955). This results in unusually rapid weathering of the carbonate steinkerns of this area.

Horizon and locality.—The individual of *Bevahites costatus coahuilaensis*, n, subsp., BEG–20288, is in a small collection labeled Austin chalk, Arroyo Tecolote, near Jiménez, Coahuila, probably collected by C. L. Baker or W. S. Adkins. It is associated with *Exogyra tigrina* Stephenson, *Eupachydiscus jimenezi* (Renz), and a species of *Inoceramus*. This would appear to be equivalent to the top of the Dessau chalk.

Genus SUBMORTONICERAS Spath, 1921

SUBMORTONICERAS TEQUESQUITENSE, n. sp.

Pl. 28, fig. 1; pl. 42, figs. 1, 2; pl. 44, figs. 4, 5; pl. 51, figs. 1, 2; pl. 52, figs. 1–4; pl. 57, fig. 4; pl. 70, fig. 1; text figs. 12b, 28b

Holotype.—BEG–34742, from downstream from the concrete spillway of the new (1932) Del Rio–Eagle Pass highway crossing of Tequesquite Creek, Kinney County, Texas; collector, W. S. Adkins, June 1932.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, widely subangustumbilicate to narrowly sublatumbilicate (U from 31.0 to 36.0, the 40.0 figure probably the result of sediment compaction), carinatitabulate, whorl section higher than wide (HF/W from 1.07 to 1.45), increasing with individual age. The greatest intercostal width is at the lateral (second) tubercle at diameters of 60 mm. and less. At diameters of more than 60 mm. the greatest intercostal width migrates dorsad to almost an umbilical position. Likewise the greatest costal diameter is at the lateral tubercle prior to the 60 mm. diameter and at the umbilical tubercle at larger diameters.

Costation is dense, costae wider than the intercostae throughout the known ontogeny, there being from 34 to 46 ribs per volution, of which about ⅓ are intercalations; this means a range of 24 to 29 primary ribs and from 10 to 17 secondary ribs. Ribs are prosiradiate throughout the ontogeny, and slightly concave from a diameter of 20 mm. to a diameter of 40 mm.

The umbilical and lateral tubercles appear simultaneously at about a diameter of 20 mm. The submarginal, marginal, and external tubercles are all present at the 15 mm. diameter, and apparently all tubercles arise independently, although conchs of less than 15 mm. diameter were not observed. Umbilical tubercles are bullate; all other tubercles are clavate, the marginal and external tubercles being more strongly clavate than the lateral and submarginal. At diameters of 100 mm. or more there is a tendency for the lateral (second) and submarginal (third) tubercles to be effaced, leaving tubercles 1, 4, and 5 only prominent at all advanced diameters.

Overlap is to the submarginal tubercle and all individuals are septate throughout. The suture is not greatly diverticulate, the ventral lobe is very long, with a short and shallow saddle.

Measurements are as follows (figures marked with an asterisk are in mm.):

D	U	HF	W	HF/W	P	S	B	T
UT–1600								
75.0	32.5	40.0	27.5	1.45	24	14		38
60.0	32.0	41.5	30.0	1.38	26	11		37
40.0	36.0	39.0	34.0	1.15				
30.0	35.0	40.0	33.5	1.19				
20.0	40.0	37.5	35.0	1.07				
UT–1367								
		30.0*	21.0*	1.43				
		25.5*	18.5*	1.38				
BEG–34743								
75.0	34.0	39.0	26.5	1.47	24	10		34
60.0	36.0	41.5	30.0	1.38				
50.0	36.0	42.0	27.0	1.55				
40.0	39.0	40.0	31.5	1.27				
BEG–34742 (holotype)								
119.0	33.0	35.0	30.5	1.15	29	17		46
100.0	35.0	40.0	32.5	1.23	28	11		39
75.0	35.5	39.5	30.5	1.29	26	12		38
60.0	31.5	37.5	31.5	1.19	25	10		35

Remarks.—*Submortoniceras tequesquitense*, n. sp., could be derived by caenogenesis from some texanitid like *Texanites shiloensis*, n. sp. In the Dessau chalk, for example, *Texanites shiloensis* occurs in numbers at the base, and *Submortoniceras tequesquitense* occurs in numbers higher up in the formation. The two species overlap in the middle, and although few texanitids are collected from the middle Dessau because of the extensive *Pycnodonte aucella* beds, there appears to be a rather complete gradation from one species to the other in these middle beds. *T. shiloensis* has not been found in the upper Dessau, above the "*Gryphaea*" beds, and *S. tequesquitense* only rarely below the "*Gryphaea*" beds.

Submortoniceras tequesquitense has many more intercalated costae than does *S. vanuxemi* (Morton), but is similar to Morton's species in the effacement or tendency toward effacement of the second and third tubercles. The tubercles in *S. tequesquitense* are more prominent than they are in *S. tenuicostulatum* Collignon, and *S. tenuicostulatum* has more intercalations at the ⅔ distance on the flank, than do most individuals of *S. tequesquitense*. UT–30568 approaches very closely to *S. tenuicostulatum* Collignon.

Horizon and localities.—*Submortoniceras tequesquitense*, n. sp., is known from the upper Dessau chalk on Tequesquite Creek (holotype), Kinney County, Texas, and from the upper and middle Dessau chalk of Travis and Williamson Counties, Texas. From the latter two counties there are fifteen fairly good individuals plus many fragments. There are a few more individuals in the Bureau of Economic Geology, and there is also a specimen at the U. S. National Museum from U. S. G. S. Mesozoic locality 16770 (also Tequesquite Creek) collected by J. A. Udden.

SUBMORTONICERAS VANUXEMI (Morton, 1830)

Pl. 54, fig. 3; pl. 56, fig. 2; pl. 57, fig. 7; pl. 58, fig. 3; pl. 67, fig. 3; pl. 69, figs. 1, 2, 6; text figs. 12ce, 26dc

=*Ammonites vanuxemi* Morton, 1830, p. 244, pl. 3, figs. 3, 4; Morton, 1834, pl. 2, figs. 3 and 4; Whitfield, 1892, pp. 253–254, pl. 42, figs. 1–5; ?Whitfield, 1892, pl. 43, figs. 1, 2; pl. 42, fig. 9

=*Mortoniceras delawarensis* (Morton) *pro parte*, in Weller, 1907, pp. 837–839, pl. 104, figs. 1–5 only; in Grabau and Shimer, 1910, p. 226, lateral view of fig. 1507 only

?=*Mortoniceras delawarense* Gaıdner, 1916, *pro parte*, pp. 391–393, pl. 12, fig. 7c; Spath, 1921b, pl. 23, figs. 4ab

Holotype.—The individual of Morton's (1830) pl. 3, figs. 3 and 4, is the holotype. It is deposited in the Philadelphia Academy of Sciences, and plastotypes at least are at the U. S. National Museum and The University of Texas.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, subangustumbilicate (U from 18 to 32), carinatitabulate, with a high whorl section, height-width ratio ranging from 1.0 in the juvenile forms at a diameter of 30 mm. or so to about 1.4 at greater diameters. The greatest costal width varies from the umbilical tubercle to the lateral node. The greatest intercostal width ranges from umbilical (only at greater diameters) to the position of the lateral tubercles.

Costation consists of moderately dense, definite costae throughout the known growth stages, with many intercalations, occurring at umbilical, lateral, or submarginal positions. Costae are wider than intercostae throughout the conch. AMNH–8915 has 15 or 16 primary ribs and 13 intercalated ribs at a 50 mm. diameter. At a diameter of 85 mm. BEG–20441 has about 19 of each. UT–30478 has about 20 primary and 18 secondary ribs at a diameter of 75 mm.

Tuberculation usually consists of a pentatuberculate system from about the 20 mm. diameter. On BEG–20436 the lateral tubercle appears at a diameter of between 15 and 20 mm. Some variation in the tuberculation occurs after the 75 mm. diameter, on some individuals the submarginal tubercle effacing or disappearing and on other individuals the lateral tubercle disappearing. The marginal and external tubercles are always clavate and the former are never canted at an angle as in the holotype of *Submortoniceras sancarlosense*, n. sp. The submarginal tubercles are either clavate or nodate, the lateral tubercles are nodate, and the umbilical tubercles are bullate and hang over the umbilical wall.

All individuals are septate throughout, and the aperture is unknown. The sutures are submortonicerine, but closer to the suture of *Texanites* than are the sutures of later species of *Submortoniceras*.

Measurements of several individuals are as follows (figures marked by asterisks are in mm.):

D	U	HF	W	HF/W	P	S	B	T
AMNH (Whitfield's 1892, pl. 42, figs. 3–5)								
51.5	33.0	39.0	27.5	1.42	16	13		29
30.0		41.5	38.0	1.09	15±		?	?
AMNH (large, unillustıated fragment)								
		35.0*	23.0*	1.52*				
60.0	26.0	46.0	33.5	1.38				
30.0	26.5	45.0	36.5	1.23				
UT–30478								
75.0	18.5	36.0	28.5	1.26	20	18		38
BEG–20436								
70.0	28 0	43.5	32.0	1.36				
50 0	29.0	47.0	35 0	1.34				
30.0	30.0	45.0	33.5	1.34	16	16		32
20.0	25 0	42.5	35.0	1.21				
15.0	26.5	46.5	40.0	1.16				

Remarks.—The largest individual of *S. vanuxemi* (Morton) known to me is BEG–20287, which is still normally costate at a diameter of 145 mm., well beyond any sizes at which *S. sancarlosense*, n. sp., and *S. vandaliaense*, n. sp., retain normal costation. However, the absence of any larger individuals in the collections leads one to suspect that perhaps costation is also effaced in the adults of *S. vanuxemi.*

There are two, perhaps three, species of which the holotype of *S. vanuxemi* (Morton) could be the juvenile; these are *S. vanuxemi*, *S. sancarlosense*, n. sp., and perhaps *S. vandaliaense*, n. sp. *S. sancarlosense* retains normal costation and 5 tubercles to about a diameter of 75 mm. and then there is a change, eventually leading to a smooth flanked shell. *S. vandaliaense* loses normal costation and tuberculation at even smaller diameters, diameters so small that the change should be appearing on individuals not much larger than the holotype of *S. vanuxemi.* The third species retains normal costation to diameters of at least 150 mm., but may lose either the lateral or the submarginal tubercle. I have not yet seen both tubercles affaced on the same individual. The holotype of *S. vanuxemi* could be the juvenile of any of these three. I have restricted it to the last species because in the collection studied by Whitfield (American Museum of Natural History collection 8915) there is a typical *S. vanuxemi* juvenile (Whitfield, 1892, pl. 42, figs. 3–5) which he illustrated, and two larger fragments, still normally costate and nodate, and unillustrated. This indicates, at least, that the *S. vanuxemi* holotype could have belonged to a larger individual of similar costation and tuberculation even at diameters in which the costation and tuberculation are partially lost in *S. sancarlosense*, n. sp., and almost completely absent in *S. vandaliaense*, n. sp.

Whitfield also figured as *Ammonites delawarense* Morton, a large ammonite (Whitfield, 1892, pl. 42, fig. 9, and pl. 43, figs. 1 and 2) which is corroded. From the illustration it could be an *S. sancarlosense*, but because of the large ribs, not present in *S. sancarlosense*, I am questionably placing it in the synonymy of *S. vanuxemi*, in spite of its very close similarity to *S. angusteumbilicatum* Collignon (1948); it most certainly does not belong to *Delawarella delawarensis* (Morton). It could be the adult of *S. vanuxemi* (Morton). The individual (Whitfield, 1892, pl. 42, fig. 9, pl. 43, figs. 1 and 2) has not been located at the Philadelphia Academy of Sciences (Reeside, May 1957, personal communication), and I could not find it at the American Museum of Natural History; thus no definite decision can be made.

Whitfield (1892, pl. 42, figs. 3–5) illustrates a good suture of *S. vanuxemi* except the suture is foreshortened on the ventral side near the ventro-orad region of the first lateral saddle, by crushing of the fossil marginally. Perhaps Whitfield overlooked this distoition.

It would appear that the sequence of *S. vanuxemi* (Morton) to *S. sancarlosense*, n. sp., to *S. vandaliaense*, n. sp., might be evolutionary from some such form as *S. tenuicostulatum* Collignon or *S. tequesquitense*, n. sp. However, the specimens are too poor, and too few for analysis, and several of Collignon's species probably fit into the sequence. *S vanuxemi* has straighter, more rectiradiate ribs and a greater consistency in the intercalation of costae than does *S. tequesquitense*, n. sp.

Assigned to *S. vanuxemi* (Morton) in this work are UT–89, BEG–20287, UT–30478, UT–30617 (a cast of the holotype), BEG–20436, UT–123, UT–1, UT–30487, UT–128, UT–1604, and questionably UT–1447, UT–130, and UT–1637, two individuals in the American Museum of Natural History (collection 8915), and an individual in the U. S. National Museum, from U. S. G. S. Mesozoic locality 25496.

Horizon and localities.—*Submortoniceras vanuxemi* (Morton) is not yet well understood. In addition to the specimens described from the Atlantic Coast (Morton, 1830, 1834; Whitfield, 1892; Weller, 1907; Gardner, 1916), BEG–20287 is from the hills of Terlingua Creek, 2 miles southeast of the Clarkson Ranch house, Agua Fria Quadrangle, Brewster County, Texas. Collected by W. S. Adkins and J. T. Twining, 1953. Other specimens are from ½ mile west of Dessau, Travis County (Burditt marl); from the "brown" at the top of the Gober chalk, east side of McFadden Quarry, Paris, Texas; from sandstone beds in the San Carlos area; and from 30 feet above the *Exogyra laeviuscula* bed on the Sabinal River, 5¼ miles north of Sabinal, Uvalde County, collected by Frank Welder and Frank Reeves. In the U. S. National Museum there is an individual of *S. vanuxemi* collected by Stephenson and Monroe (U.S. G. S. Mesozoic locality 25496) from the Tombigbee sandstone at Plymouth Bluff, Lowndes County, Mississippi. Three more coarsely ribbed specimens from the top of the Dessau chalk in Travis County may belong to this species.

SUBMORTONICERAS SANCARLOSENSE, n. sp.

Pl. 55, figs. 1–4; pl. 62, fig. 3; text figs. 20g, 27d

Holotype.—WSA–96, from the upper

part of the San Carlos beds, Tierra Vieja country, Presidio County, Texas.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, moderately subangustumbilicate (U is 25±), carinatitabulate. The whorl section is higher than wide, HF/W increasing with size and ranging from 1.18 at a diameter of 55 mm. to 1.4 at a diameter of 150 mm. on the holotype. In the juvenile whorls, where ribbing is dominant, the greatest costal whorl width is at the lateral tubercle. The intercostal width on the juvenile and the greatest costal and intercostal widths on the later whorls is just dorsad of mid flank. The flanks are lightly arched, converging from mid flank to the tabulate venter.

Costation on the juvenile of the holotype is moderately dense, with costae much wider than intercostae, costae bifurcating or intercalating. Beyond the 50 mm. diameter the costae are rapidly reduced until at a 100 mm. diameter they are faint, and cannot be seen at the 150 mm. diameter. Some of the ribs between the 100 and 150 mm. diameters break into fine costae restricted to the dorsad or first ½ of the flank.

The pentatuberculate stage is present at the smallest observable diameter, about 50 mm., with the marginal and submarginal tubercles almost bevahitine. At this diameter the umbilical bullae hang over the umbulical wall, the lateral tubercles are nodate, the marginal and submarginal tubercles are neither clavate nor bullate, but alligned prosiradiate at about 35 degrees from rectiradiate; the external tubercles are clavate. There are about 11 umbilical tubercles per ½ volution and 20 external clavae for the same ½ volution. The submarginal tubercles tend to be effaced first, completely disappearing at about the 100 mm. diameter. Shortly thereafter the lateral tubercles disappear, and at a diameter of about 125 mm. the marginal tubercles disappear. The umbilical and external tubercles are reduced, but seem to be retained throughout the ontogeny, although at diameters of 200 mm. or more the external clavae either fuse or become so elongate as to produce a tricarinate effect.

Nothing is known of the aperture or the body chamber.

Measurements of the holotype (WSA–96) are as follows:

D	U	HF	W	HF/W
150.0	24.0	48.5	34.5	1.41
100.0	25.0	41.5	33.0	1.21
50.0	25.5	39.0	33.0	1.18

Other individuals are known of this species, besides the holotype, but this material has been committed to another work. Some of these carbonate steinkerns could be measured, but only with great inaccuracy, and the measurements could be accepted only with reservations.

Remarks.—The description of *Submortoniceras sancarlosense*, n. sp., given above, is unfortunately a description of the holotype. The species of *Submortoniceras* described herein are morphospecies, almost typological species, because of the scarcity of well preserved fossils and not because of the prerogative of the writer. The relationships of the species of *Submortoniceras* are discussed, in so far as known or suggested, under the remarks under the description of *S. vanuxemi* (Morton).

S. sancarlosense, n. sp., differs from *S. vandaliaense*, n. sp., in the retention of costation to greater diameters and in the whorl section of less relative height, particularly in the stages of 50 mm. diameter or less. Of the species described by Collignon, *S. spathi* is closest to *S. sancarlosense,* but *S. sancarlosense* becomes almost bisulcate at extreme diameters whereas the ventral clavae remain distinct in *S. spathi.* Furthermore the juvenile (up to 75 mm. diameter) stage is more depressed in *S. sancarlosense.*

Horizon and locality.—The same as for the holotype; an individual at the U. S. National Museum from Lowndes County, Mississippi, U. S. G. S. Mesozoic locality 282 (Johnson collection), seems to belong to *S. sancarlosense*, n. sp.

SUBMORTONICERAS VANDALIAENSE, n. sp.

Pl. 55, figs. 6, 7; text fig. 26a

Holotype.—UT–30638, from the Blossom sandstone, on Pecan Creek (Pecan Bayou of Stephenson's, 1937, map), south of Vandalia, Red River County, Texas; collected by R. T. Hazzard.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, narrowly subangustumbilicate (U from 17.5 to 22.0); carinatitabulate. The whorl section is higher than wide (HF/W is 1.4 or more at all diameters), resulting in a high, narrow whorl section at younger diameters, with the flanks converging toward the tabulate venter from well dorsad of mid flank.

Costation is already partially effaced, even at the youngest observable diameters (50 mm. or less). The slender, sinuous, bifurcating costae break at the flank before the 75 mm. diameter. By a diameter of 100 mm. only short partial costae extend for a few millimeters dorsad of the external clavae and short costae on the first 1/4 of the flank remain.

At the earliest observable diameter the submarginal tubercle is effaced (the assumption being made that it is present in an earlier ontogenetic stage), and the marginal and lateral are almost gone, disappearing before the 75 mm. diameter, and never anything but faint at earlier diameters. The umbilical tubercles hang over the umbilicus and the ventral clavae are numerous, but low.

The holotype is septate throughout.

Measurements of the holotype (UT–30638) are as follows:

D	U	HF	W	HF/W
95.0	17.5	49.0	34.5	1.41
75.0	18 0	50.0	34.5	1.45
50.0	22.0	55.0	38 0	1.45

Remarks.—*Submortoniceras vandaliaense*, n. sp., differs from *S. sancarlosense*, n. sp., in its earlier disappearance of the texanitine costae and in the higher, narrower whorl section, particularly at younger diameters. The whorl section at diameters of 50 mm. and less is more like that of *S. vanuxemi* (Morton) than *S. sancarlosense*. *S. vandaliaense* differs from the similarly high-whorled *S. vanuxemi* in the disappearance of the tubercles and the breaking up of the costae.

The holotype, UT–30638, is the only specimen known at this writing. Further information may eventually prove that *S. vandaliaense* and *S. sancarlosense* represent the opposite subspecific end members of a biospecies, or may represent end members of a chronospecies. The third assumption is that there may be a consistent morphologic discontinuity between them, at least in North America. To prevent biostratigraphic misinterpretation they must remain nomenclatorially distinct at this time. *S. vandaliaense* may also be no more than a geographic variant of *S. spathi* Collignon, 1948, but more information is needed for substantiation of such a hypothesis.

Horizon and locality.—The same as for the holotype. The appearance of such a smooth, high-whorled *Submortoniceras* in Blossom lithology may indicate a Blossom facies at a higher level than heretofore reported.

SUBMORTONICERAS CANDELARIAE, n. sp.

Pl. 56, figs. 1, 3, 4; pl. 60, fig. 8; text figs. 20b, 28af, 29ae, 34af

Holotype.—UT–10905, from a thrust block in the Candelaria area, N. latitude 39°, 19′, 30″, and W. longitude 104°, 46′, 00″, Brewster County, Trans-Pecos Texas; collected by Ralph Duchin.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, very widely subangustumbilicate to narrowly sublatumbilicate (U from 32.5 to 45.5), arched costally, densicostate. The intercostal section is higher than wide (HF/W from 1.10 to 1.30), oval preceding the body chamber, on which the intercostal section becomes slightly trapezoidal with the flanks converging ventrad. The costal section is roughly parallel to the intercostal section, but imperfectly so because of the bumps produced by the tubercles. Thus the intercostal section appears subtabulate because of the external clavae.

Prior to the body chamber, or preceding a diameter of about 250 mm. to 300 mm., costation is dense, there being roughly 48 costae per volution, 40 primary and 8 intercalating, on UT–10304 at a diameter of 300 mm. On the last volution of UT–10905, including a complete body chamber ending at a diameter of 440 mm., there are 37 costae, 14 of which are intercalated and 23 of which are primary. Costae and intercostae are about the same width, even on the body chamber, but the costae are larger and coarser on the body chamber, accounting for the fewer ribs.

Tuberculation consists of the quadrituberculate stage and the pentatuberculate stage. Diameters of less than ca. 130 mm. have not been observed in this species, but at a diameter of 140 mm. there are 4 tubercles (1. 3, 4, and 5), the lateral tubercle being absent. At a diameter of 270 mm. UT–10304 has a weak, bullate lateral tubercle in addition to the other four. UT–10905, the holotype, has 5 tubercles at a 225 mm. diameter and at greater diameters preceding the body chamber. On the body chamber the bullate lateral tubercle is still retained, but the tuberculation is quadrituberculate because tubercles 3 and 4 fuse to form one large marginal, bullate tubercle. At this growth stage the umbilical and marginal tubercles are most conspicuous. producing a superficial binodosity. The external tubercles are clavate, all others are bullate throughout the ontogeny. There are no extra external clavae, being one of these per costa.

Overlap is to between the submarginal and marginal tubercles, usually not much more than covering the marginal tubercle. The body chamber, although distorted, is complete on UT–10905, and occupies 210° of the last whorl. The coarser costation occurs on the body chamber only. The aperture is poorly preserved, and seems to be lacking in lappets, platforms, rostra, or other types of apertural ornaments. The aperture is at a diameter of about 450 mm. and the last septum at a diameter of about 320 mm.

The suture is typically texanitid, and agrees reasonably well with those of *Submortoniceras* (Collignon, 1948). The first lateral lobe is clearly bifid and longer than the ventral lobe, and without the constriction in the middle that is so characteristic of some texanitids. The auxiliary lobe in the first lateral saddle is wider than the first lateral lobe; saddles are wider than the next dorsad lobes throughout the suture. There is a variation of the elements of the ventral saddle, but the elements are the same elements from one suture to the next.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–10905 (holotype)								
440.0	38.0	27.5	23.0	1.19	23	14		37
350.0	42.5	33.0	27.0	1.22				
300.0	37.0	36.0	28.5	1.26				
250.0	40.0	36.0	29.0	1.24				
223.0	39.5	36.0	30.0	1.20				
UT–10304								
270.0	32.5	35.5	29.5	1.20	40±	8±		48±
140.0	33.0	35.5	31.0	1.14				

Remarks.—*Submortoniceras candelariae*, n. sp., is not typical of the submortonicerines. The height-width ratio does not become as large at the greater diameters, and the costation does not tend to be effaced as in later stages in most species of *Submortoniceras*. Collignon (1948) illustrates only one coarsely costate species, *S. piveteaui*, and this species has a much higher whorl section in addition to many other features which indicate it is not related to *S. candelariae*. *S. candelariae* has many more intercalated ribs and does not have the robust ornamentation prior to the body whorl that characterizes *S. soutoni*. *S. candelariae* is included in the genus *Submortoniceras* because it has a good quadrituberculate stage preceding a good pentatuberculate stage, but does not have the additional external clavae characteristic of Campanian species of *Bevahites*. The ventral lobe of *S. candelariae* also has more auxiliary elements than does that of species of *Bevahites*, although the ventral lobe of earlier species of *Bevahites* has the long ventral lobe of the texanitines, without much auxilliary development:

later species of *Bevahites* tend to have a ventral lobe more like that of *Submortoniceras*.

Horizon and localities.—UT–10304 is from the highest calcareous beds, unit number 3 of measured section 8 (Brundrett, 1955) west of Washington Tank, east side of the Davis Mountains, Jeff Davis County, Texas. UT–10902 and UT–10905 are from fossiliferous locality number 1 (Duchin, 1953), Candelaria area, Trans-Pecos Texas. According to DeFord and Schulenberg (personal communication, 1958) this *Submortoniceras candelariae*, n. sp., horizon is at least 150 feet above the shale beds which have furnished the so-called San Carlos fauna (Hyatt, 1903; Adkins, 1933). This horizon is apparently Lower Campanian, and has yielded an ammonite very close to *Placenticeras tamulicum* (Blanford). UT–10302 is from southwest of the Kingston Ranch house near the old dam on the road to Madera Spring, northeast flank of the Davis Mountains, Jeff Davis County, Texas; and was collected by Brundrett. In all, 6 specimens are known.

SUBMORTONICERAS MARISCALENSE, n. sp.

Pl. 59, fig. 3; pl. 60, figs. 1, 4–6; text figs. 14bf

Holotype.—BEG–20478, from the concretion horizon on the west side of Mariscal Mountain, Big Bend National Park, Brewster County, Trans-Pecos Texas.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, narrowly sublatumbilicate, carinatibisculate. The whorl section is higher than wide, HF/W increasing from 1.3 at a 40 mm. diameter to about 1.5 at a 90 mm. diameter. The greatest width costally and intercostally is at the end of about the first ¼ of the flank in earlier whorls, migrating ventrad to the end of the first ⅓ of the flank at the 100 mm. diameter. The whorl section is extremely high, sub-elliptical intercostally, almost quadrangular costally because of the position of the tubercles.

Continuous costae cannot be seen, being completely effaced on the flanks at all observable stages. The costae are reduced to two rows of tubercles, (1) a row of low umbilical nodes situated right against the umbilical wall, and (2) a row of low, rounded in section, projected bullae. These ventrolateral, projected bullae duplicate the bullae found on many species of *Pseudoschloenbachia*. At a diameter of 90 mm. there are about 15 umbilical nodes and about 36 ventrolateral bullae (marginal, or the fourth tubercle of texanitines); the second (lateral) and third (submarginal) tubercles are missing. At a diameter of 170 mm. all nodes and bullae and costae have disappeared, so that the adult is a bisulcate smooth conch with an elliptical whorl section.

The fragment of outer whorl is body chamber, but the internal mold gives little information as to the aperture or the size of the body chamber.

The suture is truly submortonicerine, although the lateral auxiliary elements of the ventral lobe are more highly diverticulate than in most species of *Submortoniceras*, and the auxilliary lobe of the first lateral saddle longer than in most species of the genus. The first and second lateral lobes are well developed, but the ventral lobe is slightly longer than the first lobe.

Measurements of BEG–20478 are as follows:

D	U	HF	W	HF/W
87.0	35.5	37.0	24.0	1.49
40.0	34.0	41.5	30.0	1.37
22.5	35.5	37.5	29.0	1.31

Remarks.—*Submortoniceras mariscalense*, n. sp., is an unusual species; if normal evolutionary concepts can be applied, it should be the end product of a lineage passing through *S. rennei* Collignon (1948). Morphologically it is the least ornate species of *Submortoniceras* so far recorded, becoming completely smooth in the adult except for the bisculcate (tricarinate) venter. It is so different that it is easily characterized by the loss of ribs laterally, and later completely, and by the bisulcate venter. Also the umbilicus is more open than in most species of *Submortoniceras*, and in this respect it also resembles *S. rennei* Collignon. Collignon does not illustrate a ventral view of *S. rennei*, but in the text he discusses the number and position of the external clavae. *S. mariscalense* is the second species so far described (the other is *Reginaites durhami*, n. sp.) to complete the bisulcate (tricarinate) cycle, the cycle starting with some species of *Peroniceras*, through some texanitine lineage, through some submortonicerine lineage to the extreme, another bisulcate species, *S. mariscalense*, n. sp.

Horizon and locality.—The holotype of *Submortoniceras mariscalense*, n. sp., is from the west side of Mariscal Mountain, Big Bend National Park, Trans-Pecos Texas, from the concretion horizon of the Terlingua formation. The association includes species of *Baculites*, *Placenticeras meeki* Bohm, and a species of *Delawarella* related to *Delawarella delawarensis* (Morton). The association is probably from the upper part of the Lower Campanian.

SUBMORTONICERAS UDDENI, n. sp.

Pl 59, figs. 1, 2, 4–9; pl. 60, figs. 2, 3, 7, 9, 10; text figs. 14de, 28c

Holotype.—USNM–130739 from U. S. G. S. Mesozoic locality 18938, from near the top of the Terlingua formation, 1½ miles southwest of the east end of Maverick Mountain (Indian Head), Brewster County, Texas; collector, R. G. Yates, 1944.

Specific characters.—Oligogyral, concentrumbilicate, subangustumbilicate to very narrowly sublatumbilicate, barely carinate. The whorl section is higher than wide (HF/W ranges from 1.25 at smaller diameters to almost 2.00), but the whorls have been flattened by sedimentary load. The whorl section is flattened throughout, compressed, subtrapezoidal in costal section, elongate oval in intercostal section.

Costation is dense, but subdued, costae being effaced or nearly effaced over the flank at all diameters. The costae are reduced to two rows of tubercles, and short ventrad extensions from the umbilical tubercles and short dorsad extensions from the ventral clavae.

Tuberculation consists of low umbilical bullae and ventral clavae. The low bullae number from 13 to 17 per volution and are not present prior to a diameter of about 15 mm. The ventral clavae range from approximately 45 per volution on the holotype to as low as 30 per volution on the specimen from U. S. G. S. Mesozoic locality 16733.

All four specimens are septate throughout, and no apertures are preserved.

Measurements are as follows:

D	U	HF	W	HF/W
USNM–130740				
31 0	32.5	45 0	26 0	1.73
20 0	35 0	40 0	26.0	1.54
15.5	30 5	40.5	32 0	1.27
USNM–130741				
30 5	34 5	41 0	29.5	1 37
19 5	28 0	34 5	25 5	1 35
USNM–130739				
65 0	31 0	37 0	20 0	1.85
48 0	30.0	44.0	20 0	2 20
31 0	32 5	42 0	24 0	1 75
USNM–130742				
64 0	23 5	47 0	24.0	1.96
45 0	25 5	50 0	28.0	1.78
30 0	26 5	46.5	23.5	1.98

Remarks.—*Submortoniceras uddeni*, n. sp., is superficially like *S. mariscalense*, n. sp., but in the latter the texanitine clavae merge to form a continuous carina (bisulcate), whereas the texanitine clavae remain distinct in *S. uddeni*. In *S. mariscalense* the shoulder bullae are the fourth tubercles instead of the fifth, unless *S. mariscalense* is descended from a species like *S. uddeni* with an independent derivation of shoulder bullae from the short dorsad extensions of ribs from the texanitine clavae of *S. uddeni*. The ribs are effaced laterally on *S. uddeni*, whereas they are retained on the flanks in *S. chicoense* (Trask). If Matsumoto (1959a) is correct in placing *S. randalli* Anderson (1958) and *S. pentzamum* Anderson (1958) in synonymy with *S. chicoense* (Trask), then *Submortoniceras chicoense* shows about the same range of variation in the number of tubercles per volution and the number of costae per volution as does

S. uddeni. S. buttense (Anderson) appears to have a much more rounded venter than *S. uddeni,* in addition to the ribs on the flanks.

Horizon and localities.—Two specimens, besides the holotype, were collected by Yates from the top of the Terlingua clay, 1½ miles southeast of the east end of Maverick Mountain, Brewster County, Texas. Another individual, USNM–130742, was collected by J. A. Udden (U. S. G. S. Mesozoic locality 16773) from Austin chalk equivalents on Cow Creek, 6 miles above the junction of Cow Creek with the Rio Grande River, Kinney County, Texas. Another specimen, which may belong to *S. uddeni,* n. sp., was collected by Stephenson and Reeside in 1929 from the upper part of the Austin chalk on Little Walnut Creek near the type locality of the Burditt (U. S. G. S. Mesozoic locality 14608); this individual is at the U. S. National Museum. The label reads "Loose but probably in or a little above *Inoceramus undulatoplicatus* zone." At this locality formation B (containing the zone of *I. undulatoplicatus*) is in fault contact (Stephenson, 1937, later recognized the fault also) with the Dessau chalk. *S. uddeni* ?, from U. S. G. S. Mesozoic locality 14608, is probably from the Burditt, formation D, or the upper Dessau, certainly not older than upper Dessau. The species is Lower Campanian.

SUBMORTONICERAS CHICOENSE (Trask, 1856)

Pl. 57, figs. 1–3; text figs. 11ef, 12d

Synonymy.—The synonymy for *Submortoniceras chicoense* (Trask) has recently been given by Matsumoto (1959c, p. 126) and does not need to be repeated here.

Holotype.—Lost in the 1906 San Francisco fire, according to Anderson (1958). If plastotypes are not available it is assumed that a neotype will be selected.

Remarks.—WSA–64 agrees almost perfectly with the specimen illustrated as *S. randalli* (Anderson, 1958, pl. 46, figs. 1, 1a) and almost as well with those illustrated by the same author (1958, pl. 50, figs. 2, 2a, 3), except that the Texas specimen has the fourth (submarginal) tubercle almost effaced. My experience with different species of *Submortoniceras* indicates that the lateral (second), submarginal (third), and sometimes even the marginal (fourth) tubercles are extremely emphemeral in some species. The second tubercle may be absent on one specimen, the third on another specimen, and both in association on still another specimen, all of the same species. Some degree of effacement of one or more of these tubercles is present in *S. vanuxemi, S. tequesquitense,* and *S. chicoense.*

Horizon and locality.—WSA–64 is from the Terlingua clay, 1 mile north of Study Butte, Brewster County, Texas, and was collected by W. S. Adkins and J. T. Twining in 1953.

Genus MENABITES Collignon, 1948

MENABITES BELLI, n. sp.

Pl. 54, fig. 1; pl. 58, fig. 2, pl. 70, figs. 2–4, 7, text fig. 15a

Holotype.—UT–13, from 3 feet above the base of the Burditt marl, Turnersville Creek crossing, Travis County, Texas.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, sublatumbilicate, arched intercostally, carinate. The whorl section is higher than wide throughout, HF/W increasing with size. The intercostal section is arched laterally, oval at diameters of 40 to 75 mm. (HF/W from 1.15 to 1.35), becoming more compressed at later stages with flattened flanks converging slightly toward the venter. The greatest intercostal width is at mid flank at diameters of 40 and 50 mm., migrating dorsad at diameters of 75 to 125 mm. and is at the umbilical margin at a diameter of 175 mm. The greatest costal width is at the umbilical tubercle throughout the ontogeny, and the costal section is quadrate at diameters of 40 to 75 mm., becoming slightly trapezoidal, flanks converging ventrad, at greater diameters.

Costation is sparse to moderate, there being about 18 costae per volution at a diameter of 75 mm., increasing to about

26 costae per volution at a 175 mm. diameter. Costae are strong at diameters of 75 mm. or less, but from diameters of 125 to 175 mm. they become weak on the flanks. The part of the whorl from the 125 to the 175 mm. diameter may represent the body chamber on UT–13.

Tuberculation prior to a 100 mm. diameter is generally trituberculate, although a very low swelling appears at mid flank (lateral node) at about a diameter of 40 mm.; it takes a long time to develop this swelling into a true lateral node. At the 75 mm. diameter the costation is sparse, costae and intercostae about equal in width, with nodate umbilical tubercles, large, nodate marginal tubercles, and well developed clavae separated from the costae. Umbilical and marginal tubercles terminate the costae, and, although there are about 2 external clavae per rib, there is little or no connection between the ribs and the external clavae. At greater diameters (125 to 175 mm.) there is a pentatuberculate stage. The lateral, submarginal, and marginal tubercles are all inconspicuous on the extremely weak ribs developed at these diameters. The external clavae and umbilical tubercles are still strong. The third and fourth tubercles are very close together and may indicate a bevahitine derivation, although that part of the shell containing the derivation is missing in both specimens. At this diameter (125 to 175 mm.) there are approximately 26 ribs, each bearing four tubercles and ending dorsolaterad of the external row of clavae. There are about 52 external clavae per volution or a ratio of two external clavae per costa on the whorl ending at a diameter of 175 mm.

Suture and aperture have not yet been recovered.

Measurements of the holotype (UT–13) are as follows:

D	U	HF	W	HF/W	P	S	B	T
175.0	39.5	33.0	19 5	1.69	26—			26—
125.0	41.5	36.5	25.0	1.42				
75.0	39.5	38.0	28.0	1.36	18—			18—

Remarks.—Menabites belli, n. sp., resembles in the outer whorls *Menabites lenobeli* Collignon (1948) and *M. savornini* Collignon in the weakening ribs and tubercles of the outer whorl. However *M. savornini* is much more densicostate than is *M. belli.* Both *M. savornini* and *M. lenobeli* show a good strong lateral node at much earlier diameters than *M. belli*, n. sp. The outer whorl of UT–13 is flattened by sedimentary load, and the amount of such compression is unknown. The inner whorls of this species retain the *Australiella* (trituberculate) stage to a much greater diameter (75 mm.) than most of the described species of *Menabites. M. belli* is at the other end of a morphological series from *M. densinodosum* (Renz). However, let me emphasize that this is just a morphological series, because the horizon appears to be the same, although they have not yet been found at the same locality. Certainly the two species would not be in the same genus if someone did not believe in a lineage from one extreme to the other, but I am not ready to make a statement as to which extreme is the beginning and which is the end, or even if both are descended from some morphological intermediate. Collignon (1948) derives *Menabites* from *Texanites.* I am not yet ready to take exception to this derivation, but I will ask if it is not just as possible to have produced *Menabites* and *Australiella* from an Upper Coniacian *Protexanites?* Or could not *Menabites* be derived from an Upper Santonian species of *Australiella?* Thus forms like *M. internodosus* and *M. densinodosus* (Renz) would not be developed by caenogenesis from *Texanites* but would be developed by recapitulation from *Protexanites* and/or *Australiella* through forms like *M. belli*, n. sp.

WSA–1479 also belongs to *Menabites belli*, n. sp. The collections at the U. S. National Museum contain individuals close to *M. belli.* One, from U. S. G. S. Mesozoic locality 17991, almost certainly belongs to *M. belli.* Another, from U. S. G. S. Mesozoic locality 7611, has smoother outer whorls, but is certainly closely related. A third specimen, from U. S. G. S. Mesozoic locality 25404, is from 2 feet above the Eutaw-Mooreville boundary, Montgomery County, Alabama. This form is coarser ribbed than Texas samples of *M. belli*, and has been crushed so that identification is difficult. Its horizon should be about that of *M. belli.*

Horizon and localities.—UT–13 is from bed *b* of Durham's (1949) Burditt marl section, Turnersville Creek crossing, Travis County, Texas. WSA–1479 is from Dog Canyon in the Big Bend National Park, Trans-Pecos Texas. The closely related specimen in the U. S. National Museum, U. S. G. S. Mesozoic locality 25464, is from the basal Mooreville, 1.8 miles east of Hamburg, Perry County, Alabama.

MENABITES DENSINODOSUS (Renz, 1936)

Pl. 50, figs. 6, 7; text fig. 27a

=*Mortoniceras densinodosum* Renz, 1936, p. 8, 9, pl. 2, figs. 1, 1a
=*Mortoniceras* aff. *M. texanum* (Roemer) in Stephenson and Monroe, 1940, pl. 3, fig. 1
=*Menabites densinodosus* (Renz) in Collignon, 1948, fasc. 14, p. 44 (*101*)
=*Texanites densinodosus* (Renz) in Young and Marks, 1952, pl. 1, fig. 1 (not *Texanites densinodosus* Young and Marks, 1952, pp. 480, 482, 483)

Holotype.—According to Renz (1936) the individual he figured is in the Geological Institute of the University of Bern; it was collected from the Arroyo Tecolote near Jiménez, Coahuila. Like many authors Renz did not designate a holotype, but it seems logical to so designate the only individual he illustrated; this is no. 6 in the Böse-Staub collection at Bern.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, very widely subangustumbilicate to sublatumbilicate (U from 31.5 to 45.5), carinate. The whorl section is higher than wide, HF/W being 1.3 or greater at diameters larger than 150 mm.; the outer whorl, at least, of UT–30477 has been flattened by sedimentary load. Renz's (1936) individual has an HF/W of 1.16 at the 60 mm. diameter and 1.73 at the 120 mm. diameter, but the latter figure almost certainly represents a crushed whorl. The whorl section is quadrangular in Renz's terms, but this is an inaccurate description of the costal section. The intercostal section is a drawn-out oval, with rounded venter. The costal section is more quadrangular, but the sides converge slightly ventrad and the positioning of the external clavae gives the costal section a tabulate appearance. The greatest intercostal width varies from mid flank dorsad to the lateral tubercle. The greatest costal width is at the lateral tubercle at a diameter of 200 mm., migrating to the umbilical tubercle at greater diameters.

Costation ranges from moderate (25 more or less costae per volution) to moderately dense or dense (with 34 more or less costae per volution at a diameter of 350 mm.), increasing regularly. Costation may coarsen a little on the body chamber, but not much. Costae are prominent throughout the ontogeny and are rectiradiate, being symmetrical in section.

Tuberculation in the younger whorls has not been really determined, but has only been interpreted from observations on that part of the younger whorls which is visible. I cannot determine from Renz's figures whether there is a stage with only umbilical, marginal, and external tubercles (trituberculate stage) or not. All of the observable stages are pentatuberculate with many more external clavae than ribs; Renz says 54 external clavae and 24 ribs. On Renz's picture I count approximately 63 clavae and 24 ribs, but the individual is worn, and we may not have counted at the same diameter. On UT–30477 there are 45 external clavae and 34 ribs at a diameter of 350 mm.; this is an individual much larger than Renz's. The ratio of number of external clavae to number of ribs decreases with size in this and related species. The external clavae have no relation to the ribs, not alternating with them, not every third, or any other relation that I can find. Umbilical and lateral tubercles are nodate to about the 200 mm. diameter, becoming bullate at greater diameters. The submarginal tubercles are generally clavate at diameters preceding 75 mm., becoming nodate thereafter. Marginal and external tubercles are clavate throughout.

On UT–30477 septation ceases at about the 250 mm. diameter, and there is about 200° of body chamber from which the apertural part is broken. The suture is not recoverable on this specimen, but Renz (1936, pl. 2, fig. 1) shows part of a suture.

Measurements follow. The whorl height of the individual figured by Stephenson and Monroe is somewhat greater than that of the other two specimens, but this may result from compression by sedimentary load.

D	U	HF	W	HF/W	P	S	B	T
UT–30477								
350.0	41.5	33.0			34			34
250.0	38.5	33.5	22.0	1.52	31			31
200.0	34.5	32.0	24.5	1.31	28			28
150.0	31.5	31.0						
100.0	36.5	34.0						
Renz's 1936, pl. 2, figs. 1, 1a (estimated from Renz's figures)								
120.0	41.0	36.5	21.0	1.73	24	1		25
100.0	41.5	36.0						
75.0	45.0	35.5		.				
60.0	45.0	33.5	29.0	1.16				
USNM–76253								
216.0	47.0	47.0	crushed		31	5		36
110.0	42.5	47.0	crushed					

Remarks. — *Menabites densinodosus* (Renz) is not yet well known. I had assumed that Collignon had seen the Böse-Staub collection, but on page 10 (1948, fasc. 13, p. 55) he puts "*Mortoniceras*" *internodosum* Renz in the genus *Texanites* whereas on page 101 (1948, fasc. 14, p. 44) he puts this species in the genus *Menabites*, admitting that both of Renz's species are transitional from *Texanites* to *Menabites*. I cannot at this time tell why Collignon listed the species under *Menabites*, unless he has seen the type. It might just as well be placed in *Bevahites* or *Texanites*, except that it has the many extra external clavae which is the most practical way of eliminating *Texanites*. It was the overlooking of the importance of extra external clavae that resulted in my former misidentification of this species (Young and Marks, 1952).

The large individual (UT–30477) looks like *Texanites hourcqi* Collignon, and has 27 costae at a diameter at which *T. hourcqi* has 28 costae, but UT–30477 has extra clavae and the clavate marginal and external tubercles, not clavate in *T. hourcqi*. The whorl section of *M. densinodosus* (Renz) is higher than any species of *Menabites* or *Bevahites* described by Collignon, which also contain strong ribs at greater diameters. Whether the earlier whorls have a trituberculate stage or quadrituberculate stage preceding the pentatuberculate awaits the study of more complete ontogenies. The large individual illustrated by Stephenson and Monroe (1940, pl. 3, fig. 1) also has extra external clavae and appears to belong to *M. densinodosus* (Renz), but the whorl height is some greater; this may be the result of compaction of sediments. I have here included UT–89 as a variant of *Submortoniceras vanuxemi* (Morton), but it could be the juvenile of *M. densinodosus* (Renz). A similar juvenile from the Dessau formation is in the Wollman collection. UT–30486, from the same locality and horizon as UT–30477, is also assigned to *M. densinodosus*.

Horizon and localities.—USNM–75263 is from bed 4 of Stephenson and Monroe's Tombigbee section (1940, p. 73) at Plymouth Bluff, Lowndes County, Mississippi. UT–30477 and UT–30486 are from the *Exogyra laeviuscula* beds on the Sabinal River, Uvalde County. Collignon (1948) lists *Menabites densinodosus* (Renz) as Santonian, but this can be laid to the general misdating of the Austin chalk for many decades. *M. densinodosus* is Lower Campanian, and is from the top of the zone of *Submortoniceras tequesquitense*, n. sp., and from the bottom of the zone of *Delawarella delawarensis* (Morton).

MENABITES, s. l., WALNUTENSIS, n. sp.

Pl. 58, figs. 1, 4; text figs. 20ef, 26k

Holotype.—UT–18, from formation D, Little Walnut Creek and the old Manor Road, Bureau of Economic Geology locality 226–T–4, Travis County, Texas.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, sublatumbilicate (U from 41.5 to 47.5), intercostally arched, carinate. The section is higher than wide at diameters larger than 20 mm. (HF/W from 1.04 to 1.12). The intercostal section is subcircular, the greatest width just ventrad of the umbilical tubercle. The costal section is subquadrate, narrowing to the venter because of the absence of a tubercle in the marginal or fourth position. The greatest costal width is at the umbilical tubercle throughout the ontogeny.

Costation is generally sparse, consisting of eleven costae per volution at a diameter of 20 mm., increasing steadily and regularly to 22 costae per volution at the 70 mm. diameter. There are consistently 15 primary costae per volution at diameters beyond 20 mm., the increase in costae per volution being accomplished by the addition of intercalations. All intercalations on the outer whorl are ventrad of the marginal tubercle, but on earlier whorls intercalations may start at mid flank, dorsad of the marginal tubercle. Intercostae are two to three times the width of the costae at the 75 mm. diameter, narrowing until at a 40 mm. diameter the intercostae are the same width as the costae. Costae are really low, but seem prominent because of the tubercles. Costae are rectiradiate.

Tuberculation is trituberculate at the earliest observable diameter, about 12 mm.; there appear to be low costae at this stage. Presumably these tubercles, by their position and by comparing to other species, are umbilical (1), marginal (4), and external (5). At a diameter of between 40 and 50 mm. the lateral (second) tubercle appears. At the diameter of 73 mm., the greatest on the only individual, the quadrituberculate stage is retained, but at a diameter of 40 mm. the marginal (fourth) tubercle has migrated away from the venter until it occupies the position of the submarginal (third) tubercle of most texanitines. It appears that a bevahitine derivation of a submarginal tubercle is not to happen, but more individuals of greater size are needed for further study. Umbilical and lateral tubercles are nodate throughout; marginal tubercles are slightly clavate and external tubercles clavate.

The suture of UT–18 is unusual, probably because of variation produced by nodes. On many individuals of ammonites the septa seem to have dodged the nodes. An example is the concave margin of part of the dorsad side of the first lateral lobe clearing the lateral (second) tubercle in UT–18 (text fig. 26k). Likewise the second lobe is narrow because it fits in between the umbilical and lateral tubercles. The ventral saddle is typical of early texanitines in being long, narrow, and with few and short auxiliary elements. The first lateral saddle is narrow and the first lateral lobe is wide. Apparently this relationship is the result of the dorsal margin of the first lateral saddle remaining ventrad of the marginal tubercle, thus resulting in narrow first saddle and wide first lobe. The suture is generally simple. The individual is septate throughout and nothing is known of ultimate size, body chamber, or aperture. Overlap is to just ventrad of the marginal tubercle.

Measurements of the holotype (UT–18) are as follows:

D	U	HF	W	HF/W	P	S	B	T
73.0	42.5	33 5	30 0	1.12	15	7		22
60.0	44 0	31.5	31 0	1 05	16	6		21
52.0	44 5	32 0	20.0	1.07	15	4		19
40.0	41.5	32.5	30.0	1 08	15	1		16
30.0	41.5	35.0	33.5	1.04	11			11
20.0	47.5	32.5	45 0	0.81				

Remarks.—Menabites walnutensis, n. sp., is obviously based on a juvenile specimen; it has little to relate it to any heretofore described texanitines. The trituberculate stage followed by a quadrituberculate stage really should make it a *Delawarella* were taxonomy so simple. However, the pentatuberculate stage is not reached in the individual available to me, even at a 75 mm. diameter, and the individual is more evolute than *Delawarella* and does not look like any described species of *Delawarella*. Since there is only one individual the species will remain a puzzle until more information is obtained. Although assigned to *Menabites* the development of the whorls appears to be leading to a form with the general shape of *Submortoniceras*.

Horizon and locality.—The holotype was collected by Caldwell in 1931, and is from Little Walnut Creek and old East Avenue, Austin, Travis County, Texas. The horizon is in formation D and should be Lower Campanian. There is always the chance that the specimen washed downstream, since I do not know the circumstances under which it was collected, but the fossil is little worn and the tubercles are sharp and well preserved. It does not seem to me it could have travelled very far without becoming more abraded.

Genus DELAWARELLA Collignon, 1948

DELAWARELLA DELAWARENSIS (Morton, 1830)

Pl. 55, fig. 5; pl. 61, figs. 1–6; pl. 63, fig. 2; text figs. 15e, 20d, 25b, 26bfg, 27c, and 29f

=*Ammonites delawarensis* Morton, 1830, p. 244, pl. 2, fig. 4; Morton, 1834, p. 37, pl. 2, fig. 5; Whitfield, 1892, pl. 42, figs. 6–8

=*Mortoniceras delawarense* (Morton) in Weller, 1907, p. 837, pl. 103, fig. 1 only; in Pervinquiere, 1907, p. 243, pl. 11, figs. 21ab; in Grabau and Shimer, 1910, p. 227, fig. 1508, excepting the suture, p. 226, fig. 1507, ventral view only

?=*Delawarella delawarensis* (Morton) in Groot, Organist, and Richards, 1954, pl. 7, fig. 5

Holotype.—The small ammonite pictured by Morton (1830) in plate 2, fig. 4, now deposited in the Philadelphia Academy of Sciences.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, widely subangustumbilicate, carinate. The whorl section is higher than wide except at the smallest diameters (HF/W from 0.94 to 1.1). The whorl section is generally circular intercostally, although some slightly higher whorled forms may have an oval section. The costal section varies largely according to the development of the lateral tubercle. The greatest intercostal width is at the lateral tubercle. The greatest costal width is at the lateral tubercle where it is well developed, but where the lateral tubercle is weak, the greatest costal width is at the umbilical tubercle.

Costation ranges from a moderate 29 in the neighborhood of the 30 mm. diameter to a more dense 35 or more at the 50 mm. diameter. The number and degree of bifurcations and intercalations are extremely variable, some forms, like UT–27, having only a few bifurcations whereas UT–19818 has many intercalations. Rarely is there an umbilical bifurcation, most intercalations and bifurcations occurring at the lateral or submarginal positions. Costae are wider than intercostae.

Tuberculation of the young is extremely variable, the umbilical, submarginal, and external tubercles usually appearing prior to the 12 mm. diameter. On UT–27 the lateral tubercle appears at about the 20 mm. diameter and the marginal at about the 23 mm. diameter. All tubercles are present on BEG–20322 at a 24 mm. diameter. On the holotype the submarginal tubercles appear at about the 25 mm. diameter and the lateral tubercle probably not until about the 30 mm. diameter, although this region is badly corroded. The stage prior to the 20 mm. diameter is menabitine, with umbilical, submarginal, and external tubercles.

All of the individuals at my disposal are septate throughout, even the large fragment more questionably assigned to this species, UT–1514. Measurements follow. The figures marked by an asterisk are in mm.

D	U	HF	W	HF/W	P	S	B	T
BEG–34748								
		46 5*	45 0*	1.03				
		37.5*	37.0*	1.01				
UT–1514								
		62.5*	58 0*	1.08				
		57 0*	52.0*	1 10				
UT–19818								
75 0	25 5	48 0						
50.0	28.0	45.0	46.0	0.98	22	15		37
40.0	27.5	42.5	41 0	1 03				
24 0	29.0	44 0	41.5	1.05				
UT–27								
50.0	33 0	44 0	42 0	1 05	20	9	2	33
30.0	33.5	40.0	40.0	1.00	19		5	29
20.0	32 5	37.5	40.0	0.94				

In addition to the above fossils, the following have been assigned to this species: UT–30627, UT–19817, UT–30618, UT–30619, UT–30616 (cast of the holotype), UT–30721, and, questionably, UT–30659. An individual in the U. S. National Museum, from U. S. G. S. Mesozoic locality 7706, should probably be assigned to *Delawarella delawarensis* (Morton).

Remarks.—Conservatives should be pleased with my interpretations of *Delawarella delawarensis* (Morton), because it is obvious that I have interpreted this species with more latitude than has Collignon (1948). Some of the forms, like UT–27, actually appear to be transitional to *Texanites dichotomous* Collignon. Future work may prove that UT–27 does not belong to this group, but definite discontinuities between forms like UT–27 and the holotype cannot be demonstrated and there seems to be no stratigraphic reason for separating them.

Delawarella delawarensis is more robust and more coarsely costate than other species described by Collignon (1948), excepting the entirely different *D. roedereri* Collignon. Also most of Collignon's species have ribs projected farther onto the venter than does *D. delawarensis.* UT–19818 has the marginal and submarginal tubercles much too close together for this species, and the later ribbing approaches that of *Delawarella jeanetti* Collignon (1948, pl. 31, figs. 2, 2a). Although the projected ribs in UT–19818 may be the result of distortion, I believe that the juveniles of this species (up to 50 mm. diameter) vary enough to include this specimen.

UT–19818 is associated with forms like BEG–34748 and UT–1514, all coming from the same horizon and locality, and they probably belong to the same species in spite of the variation. I am not at all satisfied with the present status of this species, but the rather poor state of preservation of the fossils, the lack of good complete adult stages, and the small sample prevent any further conclusions. In addition to those mentioned above, UT–30627, UT–30721, UT–31308, UT–31309, UT–31312, UT–30720, BEG–340, and BEG–19902 are assigned to *Delawarella delawarensis* (Morton).

Horizon and localities.—UT–27 is from the Austin chalk, but locality and horizon information has been lost. Presumably it is from the Burditt marl or formation D. BEG–340 is from Travis Heights, Austin, Travis County, and cannot be younger than formation D. BEG–19902 is from the concretion zone in the Terlingua clay, ½ mile east of the Boquillas–Hot Springs road junction, Big Bend National Park. UT–19817 is from the San Carlos beds, collected by Dumble and Cummins, and UT–19818 is from the sandy members of the San Carlos formation of Miller (1957). There are other specimens from the San Carlos beds in the Adkins collections. Other specimens are from 1 mile west of the state line (Arkansas-Oklahoma), McCurtain County, Oklahoma, on the road from Foreman, Arkansas, to Tom, Oklahoma, collected by R. T. Hazzard; these are from beds equivalent to the Gober chalk. Another specimen in the U. S. National Museum, U. S. G. S. Mesozoic locality 7706, is from the bed of Sabinal Creek, left bank, about 4 miles north of Sabinal, Uvalde County, and was collected by L. W. Stephenson, in 1912. Further specimens have been collected by Oscar Paulson from beds above the Gober, as high as the phosphate nodule zone, 250 feet above the Gober chalk, on Sulphur Creek in Fannin County, Texas.

DELAWARELLA SABINALENSIS, n. sp.

Pl. 54, fig. 2; pl. 63, figs. 1, 3, 4; text figs. 20c, 21e, 26c

Holotype.—The holotype of the species is WSA–13, from the Anacacho limestone on the Sabinal River, Bureau of Economic Geology locality 17320.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, narrowly sublatumbilicate, strongly carinate at earlier diameters, barely carinate at intermediate diameters, losing the keel at about the 250 mm. diameter. The intercostal whorl section is circular at diameters of 150 mm. or less, becoming oval at greater diameters. The height-width ratio is about unity at the 150 mm. diameter, increasing to about 1.45 at a diameter of 250 mm., and retaining that ratio from there to the aperture of the conch.

Costation is coarse at all stages, there being 18 primary ribs and 12 secondary ribs on the holotype at the 250 mm. diameter; this number increases only a little at the 350 mm. diameter.

Beyond a diameter of 200 mm. the keel disappears and the ribs continue across the venter in great wrinkles. Although the holotype is septate through the 345 mm. diameter, the later ribs appear to be gerontic. The tuberculation is generally normal for species of *Delawarella*, but the grossness of the costation makes the tubercles appear insignificant. At a 150 mm. diameter weak tubercles on the ribs result in the pentatuberculate stage; earlier stages are unknown. This pentatuberculate condition continues through the 250 mm. diameter, but by a diameter of 300 mm. the marginal tubercle is migrating dorsolaterad and the submarginal and lateral tubercles are fused so that the adult is quadrituberculate.

The suture is a good *Delawarella* suture with ventral and first lobes about equal in width, and with well developed first lobes and first saddles; the second saddles and lobes are reduced and not greatly diverticulate. Neither are the first lobes greatly diverticulate. Aperture and body chamber are unknown.

Measurements of two individuals are as follows:

D	U	HF	W	HF/W	P	S	B	T
WSA–13 (holotype)								
345.0	38.5	35.0	25.0	1.40	21	14		35
250.0	38.0	37 5	25.5	1.47	18	12—		30—
150.0	39.5	41.0	38.5	1.07				
UT–10731								
250.0	37.0	34.0			19	18		37
200 0	36.5	33.0						

The crushed claystone internal mold (UT–10731) shows no septation; considering its size, it is probably not a body chamber.

Remarks.—*Delawarella sabinalensis*, n. sp., does not retain the circular whorl section to the advanced diameters at which it is retained by *Delawarella danei*, n. sp., (="*Mortoniceras*" *delawarense* Dane, 1929). The only other individual with the coarse ornamentation of *D. sabinalensis* is the species described and named by Collignon (1948, pl. 32, figs. 1, 1ab) as *Menabites* (*Delawarella*) *roedereri*. The suture of Collignon's species is almost identical with that of *D. sabinalensis* (text figs. 20c and 21c), but the costation up to the 100 mm. diameter is not as robust, the height increases much earlier in relation to the width, and the width of the venter from external clava to external clava is relatively much wider in *D. roedereri*.

In addition to the holotype (WSA–13) UT–10731 can be assigned to this species. In the U. S. National Museum there is a specimen of *D. sabinalensis*, n. sp., from U. S. G. S. Mesozoic locality 18104, and there is also an unnumbered individual in the Bureau of Economic Geology of Texas. The few individuals show but little range in variation.

Horizon and localities.—UT–10731 is from the lower Taylor clay on Walnut Creek, Travis County, Texas. The only information available on WSA–13 is that it is from the Anacacho limestone on the Sabinal River, Uvalde County. The specimen in the U. S. National Museum (U. S. G. S. Mesozoic locality 18104) is from $2\frac{1}{2}$ feet above the base of the Taylor clay, from near Medio Creek on Protranca Road, Bexar County. It was collected by A. N. Sayre, 1938. The unnumbered specimen in the Bureau of Economic Geology, The University of Texas, is from the concretion horizon in the Terlingua formation on Tornillo Creek, Big Bend National Park, Trans-Pecos Texas.

DELAWARELLA CAMPANIENSIS (Grossouvre, 1894)

Pl. 64, figs. 2, 6; pl. 67, fig. 2; text figs. 24a, 25a

Holotype.—Presumably the individual illustrated by Grossouvre (1894) on pl. 13, figs. 1ab.

Measurements of BEG–34746 are as follows:

D	U	HF	W	HF/W	P	S	B	T
125.0	45.5	31.0	25.5	1.22	23	2		25
100.0	47.0	32.0	25.5	1 25	20	5		25
75.0	44.5	32 0	26.5	1.20				
60.0	42.5	31.5	26.0	1.23				

Remarks.—BEG–34746, the single specimen from the top of the Dessau chalk, is badly weathered, but otherwise resembles Grossouvre's (1894) specimen which he illustrated on pl. 13, figs. 1ab, in rib count, whorl section, and degree of involution. The individual may be compressed by sedimentary load; consequently the figures for width of whorl and the height-width ratio may be erroneous.

Horizon and locality.—BEG–34746 is from the top of the Dessau chalk on Big Walnut Creek, downstream from the Cameron Road, Travis County, Texas.

DELAWARELLA DANEI, n. sp.

Pl. 57, fig. 6; pl. 62, figs. 1, 2; pl. 64, figs 1, 5; pl. 65, figs. 1, 2; pl. 66, figs. 3, 4; text figs. 24e, 33b

=*Mortoniceras delawarense* (Morton) in Dane, 1929, pl. 10, figs 1, 2

Holotype.—UT–30646, from a formation equivalent in age to the Gober chalk, 1 mile west of the Oklahoma line on the highway from Foreman, Arkansas, to Tom, Oklahoma, McCurtain County, Oklahoma, sec. 28, T. 9 S., R. 27 E.; collected by R. T. Hazzard.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, carinate. The whorl section is subcircular, being wider than high prior to the 100 mm. diameter, width about the same as height from the 100 mm. to the 200 mm. diameter, higher than wide beyond 200 mm., but not greatly compressed. The greatest intercostal width is just dorsad of mid flank. The greatest costal width is at the horn (marginal tubercle) at diameters of less than 200 mm.; at greater diameters it migrates to about mid flank and at a diameter of 400 mm. is just dorsad of mid flank.

Costation is sparse, ranging from 14 ribs to 19 ribs per volution at diameters of less than 150 mm., gradually increasing from 17 to 25 at diameters of 150 mm. and greater. The ribs are all primary, and there are about 2 ventral clavae per rib, although some ribs fail to have intercalated ventral clavae. Thus WSA–140, at a diameter of 90 mm., has about 24 external clavae for 19 ribs, whereas WSA–12 has exactly 2 ventral clavae per rib at a diameter of 200 mm. and greater. UT–30628, at a diameter of 150 mm. has 35 external clavae and 25 ribs. At more advanced diameters (200 mm. and greater) the equilibrium of 2 external clavae per rib is reached.

Tuberculation is that of *Australiella.* In the more juvenile forms (up to 150 mm. diameter) there are three tubercles on the holotype, 1, 4, and 5. On the other hand UT–30628 shows all five tubercles at the 80 mm. diameter, but the lateral (second) and submarginal (third) are extremely weak. At these early diameters tubercle 4 (marginal) is so large on most specimens that it masks the lateral and submarginal. The effect of the tubercles is nodate except for the external clavae. The submarginal, when exposed, is faintly clavate. At diameters beyond 150 mm. the ribs become more conspicuous, the tubercles less conspicuous, relatively, and eventually tubercles 2, 3, and 4 fuse to form a long, raised rib with a ventral clava at one end and an umbilical node at the other.

UT–30646 is septate beyond the 305 mm. diameter, and there is 180° of body chamber, but no apertural margin is observable. No sutures have been recovered from any of several specimens.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–30646 (holotype)								
450 0	41.5	40.0	35.5	1.13	22			22
350.0		44.0	33.0	1.35	21			21
250 0		35.5	36 0	0 97	20			20
120 0	36 5	43 0	46.5	0 92	16			16
100 0	37.0	41 5	48.5	0 85	15			15
75.0	37.5	42.0	52 5	0.80	14			14
60 0	33 0	35 0	40.0	0.87				
WSA–140								
90.0	40.0	34.5	44.5	0.73	19			19

D	U	HF	W	HF/W	P	S	B	T
WSA–12								
350.0	37.0	38.5			20			20
270.0	33.5	42.0			18			18
200.0	32.0				17	.		17
150.0	32.0	40.5	38.5	1.05				-
WSA–11								
410.0	34.0	34.0	crushed		23			23
300.0	39.5	31.0	crushed		22			22
200.0	34.0	37.5	crushed					
UT–30628								
150.0	36.5	36.5	40.5	0 90	25			25
100.0	34.5	34.0	37.0	0.92	24			24
75 0		34.0	40.0	0.85	19			19
UT–30661								
150.0	32 5	46 5	42 0	1.11	21			21
100.0	33 5	38 5			21			21
75.0	34.0	39.5	44 0	0 89				

In addition to the individuals listed above, UT–30674, UT–31303, and the individual illustrated by Dane (1929, pl. 10, figs. 1, 2) can be assigned to this species.

Remarks.—If only one had more coarsely ornamented juveniles, one would place *Delawarella danei*, n. sp., in the genus *Australiella* Collignon. However, *D. danei* seems to be no more than a coarsely ornamented geographic subspecies of *Delawarella delawarensis* (Morton), and *D. delawarensis* does occur with *D. danei* in Texas. Individuals like UT–30628 (pl. 64, fig. 1; pl. 65, fig. 2; pl. 66, fig. 3) are even transitional to more coarsely ornate individuals of *Delawarella delawarensis.* For this reason it seems best to retain *D. danei* in the genus *Delawarella.* Whether other species of *Delawarella* are retained in *Australiella* because only the juvenile forms are known is conjectural. *D. danei* is more coarsely ornate than any other species of *Delawarella,* except *D. roedereri* Collignon and *D. sabinalensis,* n. sp. *D. roedereri* and *D. sabinalensis* both have higher whorl sections in the more adult forms (diameters beyond 150 mm.) and also have intercalated ribs. Juveniles of *Delawarella danei* have the same appearance as *Australiella moreti* Collignon, which Collignon (1948) lists as Middle Campanian. *A. vinassai* (Venzo, 1936) has less clavate tubercles, and the marginal tubercles are displaced much further dorsad than on *D. danei.*

Horizon and localities.—The localities for the individuals in the Adkins collections have not yet been determined, but the lithology is the same as that of the holotype of *Delawarella danei,* n. sp. UT–30674 is from the "red rock" of the Gober chalk, Maness quarry, Roxton Area, Lamar County, Texas; collector, R. T. Hazzard. UT–30628 and UT–30661 are from the same locality and horizon as the holotype and also were collected by R. T. Hazzard. *Delawarella danei* is from the zone of *Delawarella delawarensis,* Lower Campanian.

Genus AUSTRALIELLA Collignon, 1948

=*Austinites,* Adkins, 1933, *nomen nudum*

AUSTRALIELLA AUSTINENSIS, n. sp.

Pl. 64, figs. 3, 4; pl. 65, fig. 6; pl. 67, figs. 4–6; text fig. 28e

=*Austinites,* n. gen. [*nomen nudum*] Adkins, 1933, p. 407

="a new ammonite genus closest related to *Mortoniceras*" in Adkins, 1933, p. 453

Holotype.—WSA–65, from Bureau of Economic Geology collection 2576, 1½ miles southeast of Austin. The fossil was probably part of the Third Texas (Dumble) Survey collections, and was collected when Austin was much smaller than now. The fossil is Senonian.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, sublatumbilicate, carinate. The whorl section is always wider than high (HF/W ranging from 0.68 to 0.74) intercostally, being a depressed circle, and costally a depressed quadrangle.

Costation is coarse, ranging from 13 to 15 ribs per volution. There are about two ventral clavae per rib. From the horn each rib projects orad to a clava. Tuberculation consists of umbilical nodes, horns (presumably the fourth or marginal, but the submarginal or third has not been eliminated as the tubercle possibly forming this horn), and the ventral clavae.

Aperture and sutures are unknown, since both individuals are septate throughout, but not illustrating a good suture.

Measurements are as follows:

D	U	HF	W	HF/W
WSA–65 (holotype)				
75.0	36.0	42.0	61.5	0.68
48.0	37.5	39.5	61.5	0.68
UT–2				
45.0	48.0	41.0	56.0	0.74

Remarks.—*Australiella austinensis,* n. sp., is the oldest of the species of *Australiella.* It is closer morphologically to *A. australis* (Besaire) than to other species of the genus. However, the horns are not as long, the intercalated clavae have less well developed ribs, and the umbilical tubercles are stronger on *A. austinensis. A. vinassai* (Venzo, 1936) is as robust in ornamentation as *A. austinensis,* but is higher whorled.

Horizon and localities.—Besaire's species, *Australiella australis,* is Middle Campanian according to Collignon (1948). *A. austinensis,* n. sp., is probably Lower Santonian, but could be lowest Campanian. The holotype was collected for the Dumble Survey 1½ miles southeast of Austin. This would place it either in formation B, Lower Santonian, or the Dessau chalk, Lower Campanian. UT–2 is from Duval Street, Austin, Travis County, Texas, and the label reads "from the contact with the Buda." Since there is no Buda on Duval Street, this leaves some doubt as to the validity of any part of the label. All that can be said at this time is that *Australiella austinensis,* n. sp., is either from formation B or the Dessau chalk. Formation B seems the most likely if the label information is at all correct, because Duval Street ran on Formation B for most of its length in the Austin of 70 years ago, when this fossil was collected.

AUSTRALIELLA PATTONI, n. sp.

Pl. 65, figs. 4, 5; pl. 66, figs. 1, 2, 5, 6; pl. 68, figs. 1–3, 6; text figs. 24b, 26h, 33ac, 34dg

Holotype.—UT–18122B, Dessau chalk, Travis County, Texas.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, very narrowly sublatumbilicate, arched, carinate. The whorl section is slightly higher than wide throughout the ontogeny, HF/W ranging from 1.09 to 1.20. The intercostal section is subcircular, with greatest width at mid flank at all growth stages observable. The costal section is quadrate at all stages because of the positioning of the large marginal and umbilical tubercles.

Costation is sparse, there being from about 15 to about 20 ribs per volution, the lower numbers occurring at the smaller diameters. Costae are slightly prosiradiate, some with a sharp genuflection orad between the marginal tubercle and the external clava. Costae are weakened just dorsad of mid flank; costae and intercostae are about the same width.

The umbilical tubercles are nodate throughout and are located almost on the umbilical wall. The marginal tubercles form small horns projecting ventrolaterad at an angle of about 60° with the plane of coiling. The external clavae are small, neat, and average 2 to 3 per rib, but there is no consistent relationship in the number of ventral clavae to costae.

All specimens are septate throughout. The ventral saddle is typically texanitine, most of the elements lying just mediad to the external clavae. The first saddle is extra wide, with the auxilliary lobe displaced ventrad to accommodate the large marginal horn within the loop of the dorsad auxilliary saddle. The first lateral lobe covers most of the flank between the two tubercles, and is extremely short, and bifid, with two extremely long auxilliary fingers. Insufficient individuals are known to determine the variability of the sutural pattern. The sutures of such ornate species are usually extremely variable. Thus, as yet, the important sutural features cannot be stated.

Measurements of four individuals follow. Figures marked with an asterisk are in mm.

D	U	HF	W	HF/W	P	S	B	T
UT–18122B (holotype)								
64.0	36.0	36.5	31.5	1.17				
50.0	33.0	38.0	33 0	1.15				
40 0	34.0	41.5	35.0	1.18				
UT–18122A								
		40.0*	37.0*	1.08				

D	U	HF	W	HF/W	P	S	B	T
BEG–34747								
60.0	32.5	40.0	35.0	1.14	16		2	20
40.0	35.0	42.5	40.0	1.06	15		1	17
30.0	33.5	43.5	38.5	1.13	16			16
BEG–20278								
100.0	36.0	42.0	35.0	1.20	20			20
75.0	33.5	41.5	40.0	1.03	19			19
60.0	34 0	41.0	39.0	1.04	18			18
50.0	35.0	43.0	39.0	1.05	19			19
40.0	32.5	40.0	40.0	1.00	19			19
25.0	34.0	44.0	44.0	1.00	16			16

Remarks.—*Australiella pattoni*, n. sp., is different from all other species of *Australiella* in retaining a consistent whorl shape and a consistent ornamentation through at least one complete volution. *A. antsirasitaensis* Collignon, *A. australis* (Besaire), *A. subaustralis* Collignon, *A. moreti* Collignon, *A. vinassai* (Venzo), and *A. welderi*, n. sp., all complete rather remarkable changes in ornamentation and whorl section within one volution. *A. pattoni* can be distinguished from *A. austinensis*, n. sp., because of the very depressed whorl section of the latter. *A. vinassai* (Venzo, 1936) has the intercalations at mid flank; such intercalations are absent in *A. pattoni.*

The species is named for J. L. Patton, whose master's thesis (1932) was on the paleontology of the Austin chalk. Patton's thesis was of great aid in checking locality data and other information on important fossils that would have been lost otherwise.

In addition to the specimens listed above UT–6 belongs to *A. pattoni*, and there are two more specimens in Miss Wollman's collection.

Horizon and localities.—Only seven individuals of *Australiella pattoni*, n. sp., are known to the writer. Five of these are from the Dessau chalk, the holotype from Pilot Knob, Travis County. UT–18122A is from the Dessau formation, just above the *Pyconodonte aucella* biostrome, East Avenue and Thirteenth Street, Austin, Travis County, Texas. BEG–34747 is from the Dessau chalk on Big Walnut Creek, just downstream from the Cameron road crossing, Travis County, and the two specimens in the Wollman collection are from the Dessau chalk on Williamson Creek, collected in place with *Submortoniceras tequesquitense*, n. sp. BEG–20278 is from the northeast flank of the Davis Mountains, Jeff Davis County, Texas; the exact horizon is undetermined in this faulted area. A specimen in the U. S. National Museum (U. S. G. S. Mesozoic locality 769) from the lower falls of the Guadalupe, just below the Missouri Pacific railroad bridge, New Braunfels, Comal County, Texas, was collected by T. W. Stanton in 1890; it seems to belong to *Australiella pattoni*, n. sp. All individuals are Lower Campanian, zone of *Submortoniceras tequesquitense*, n. sp.

AUSTRALIELLA WELDERI, n. sp.

Pl. 65, fig. 3; pl. 68, figs. 4, 5; text figs. 25kn

Holotype.—UT–30479, from the Anacacho limestone, from 30 feet above the *Exogyra laeviuscula* beds on the Sabinal River, 5¼ miles north of Sabinal, Uvalde County, Texas; collected by Frank Welder.

Specific characters.—Oligogyral, excentrumbilicate, gradumbilicate to subgradumbilicate, narrowly sublatumbilicate, broadly arched, carinate. The whorl section is wider than high at diameters of 60 mm. and less, becoming higher than wide at diameters of 75 mm. and more. The intercostal whorl section is squat and tumid, being subcircular to a diameter of 60 mm., expanding rapidly in height from there to the 75 mm. diameter at which it becomes oval to subquadrate. The greatest intercostal width remains near mid flank throughout the ontogeny. The costal whorl section is a little more squarish than the intercostal, the greatest width at the marginal tubercle at diameters of less than 50 mm., migrating to the umbilical tubercle at diameters of greater than 50 mm. The umbilical diameter (U) decreases proportionately, with age.

Costation is sparse, there being 21 primary ribs on the outer whorl, the only whorl visible. Costae are about twice as wide as intercostae throughout the ontogeny, are prosiradiate to rectiradiate, with a strong adorad geniculation ventrad of the marginal tubercle. The external clavae appear to be related to the ribs; there are 38 clavae on the whorl which bears 21 ribs. Twenty-one of the clavae terminate the primary ribs; 17 of them are intercalated ventrad of the marginal row of tubercles. There are, of course, three rows of tubercles, umbilical, marginal, and the external. At diameters of less than 50 mm. the marginal tubercles are almost small horns, decreasing in relative size at diameters of more than 50 mm. and becoming merely nodate. The umbilical tubercles are nodate throughout the ontogeny, and preceding the 50 mm. diameter are smaller than the marginal tubercles.

The suture and aperture could not be recovered, but part of the body chamber seems to be preserved.

Measurements of the holotype (UT–30479) are as follows:

D	U	HF	W	HF/W	P	S	B	T
75.0	35.5	42 5	36 5	1 16	21			21
60 0	36 0	36 0	44 0	0 82				
40 0	41 5	39 0	48 5	0 67				
30.0	45 0	45 0	51 5	0.86				

Remarks.—*Australiella welderi*, n. sp., seems to be more closely related to *A. antsirasiraensis* Collignon (1948, pl. 28, figs. 3, 3a) than to other species of the genus, lacking the intercalated costae of *A. subaustralis* Collignon, and with greater spacing between the first and fourth tubercles. Costation is not as coarse in *A. welderi* as in *A. australis* (Besaire), and the whorls of *A. moreti* Collignon remain more tumid to all diameters. At diameters of 70 mm. the costae become pinched and narrowed between the umbilical and marginal tubercles in *A. antsirasiraensis* Collignon. The diameters of the umbilicus of *A. antsirasiraensis* and *A. welderi*, n. sp., are similar as are the densities of costation and the general configuration. *A. pattoni*, n. sp., retains the marginal horns to much later diameters than does *A. welderi*. *A. vinassai* (Venzo, 1936) does not have marginal horns, and has mid flank intercalations.

Horizon and localities.—The holotype of *Australiella welderi*, n. sp., is from the Anacacho limestone, Sabinal River, from 30 feet above the *Exogyra laeviuscula* beds, Uvalde County, Texas. It is from the zone of *Delawarella delawarensis* (Morton) and was found in association with *Submortoniceras vanuxemi* (Morton). A second specimen is in the U. S. National Museum (U. S. G. S. Mesozoic locality 1878) and is also from the Anacacho limestone (horizon undesignated), Sabinal River, Uvalde County, Texas.

Genus DEFORDICERAS, n. gen.

Type species.—*Defordiceras hazzardi*, n. sp.

Generic characters.—Oligogyral, concentrumbilicate, subgradumbilicate, widely sublatumbilicate, arched. The whorl section is oval, slightly higher than wide (HF/W from about 1.1 to 1.2) in the adult, more flat-sided in young. Costation is dense in the earlier whorls, sparse in the later whorls. Ribs on the earlier whorls contain many bifurcations, but are single and primary on the outer whorls. Tuberculation is reduced on the earlier whorls, but becomes pronounced on the outer whorls where there are three tubercles on each side, in texanitid terms the external (fifth), the submarginal (third), and the lateral (second); the designation being morphological, not phylogenetic. There is no keel.

The suture, only partly known, is definitely acanthoceratine, the elements of the suture not highly frilled.

Horizon.—Probably Santonian.

DEFORDICERAS HAZZARDI, n. sp.

Pl 69, figs. 3–5: text fig 21bf

Holotype.—BEG–20285, from the Terlingua formation, Agua Fria Quadrangle, Brewster County, Texas.

Specific characters.—Since only the holotype of the species is known and the genus is monospecific, the specific characters are the same as those for the genus, with the following details which seem to be of specific importance only. The species is more flat-sided in the young than in the adult, and in the specimen this juvenile flattening has been emphasized by sedimentary processes. The earlier whorls are densicostate, the last whorls more sparsicostate, but the last observable whorl is septate throughout. There are about 20 ribs on the last volution and an estimated 40 ribs per volution on the preceding whorl. The ribs are low on the inner whorls, with intercostae and costae about equal in width. On the last whorl costae are about ½ the width of the intercostae, and the ribs are high and symmetrical in section. The ribs on the outer whorl are single and primary; on the preceding whorls there are many bifurcations.

Tuberculation is reduced on the earlier whorls, but becomes pronounced on the last whorl where there are three tubercles on each side, all nodate, and positioned, in morphological terms of the texanitines, as external (fifth), submarginal (third), and lateral (second). There is no keel.

The suture, only partly preserved, is definitely acanthoceratine, the ventral lobe is slightly asymmetrical to the right. The elements of the suture are not highly frilled, but the first saddle bears a small auxiliary lobe asymmetrical dorsad, and there is a well developed first lobe, the trend of which is concave ventrad.

Measurements of the holotype (BEG–20285) are as follows:

D	U	HF	W	HF/W	P	S	B	T
170.0	43.5	35.5	31.0	1.14	22±			22±
125.0		38.5						
100.0		37.0						

Remarks.—*Defordiceras hazzardi*, n. gen., n. sp., might at first glance be considered a monstrosity. Upon further examination one fails to find anything of which it could be a monstrosity. The entire lack of any keel, and the possession of entirely nodate, rather than clavate external tubercles indicate no close relation to any late texanitine lineage. Furthermore, although definitely acanthoceratine, the suture, particularly the first lateral lobe and first lateral saddle, shows no relation to texanitine sutures, but is closer to some sutures of adult *Prionocycloceras guayabanum* (Steinmann) (text fig. 33d) or Turonian collignoniceratines. Other collignoniceratids, such as Peroniceratinae, Barroisiceratinae, and Lenticeratinae, show even less relationship to *Defordiceras*, n. gen. Although very badly preserved the ribs indicate a steady, ontogenetic development, rather than some strange accident to a half-grown animal.

Whether or not *D. hazzardi* can be related to some such form as *Bevahites* (?) *bicrenulatus* Collignon (1948, pl. 27, figs. 1, 1a) by the loss of the keel and the ventrad migration of the ventral clavae or external nodes is problematical. *B.* (?) *bicrenulatus* has more than three rows of tubercles per side, but the tubercle development in *Defordiceras* is not yet known, because of missing ontogeny. *Defordiceras hazzardi*, n. sp., is probably older than the Lower Campanian age given by Collignon (1948) for *B* (?) *bicrenulatus.*

Horizon and locality.—The holotype and only specimen of *Defordiceras hazzardi*, n. gen., n. sp., is from float, below the *Inoceramus undulatoplicatus* zone, Agua Fria Quadrangle, Brewster County, Texas. This means it could have fallen to its present position from anywhere in the Santonian or Lower Campanian, but the preservation of the tubercles on the outer whorl of the steinkern is so good that the fossil probably did not wash far, and is from the Santonian.

Subfamily BARROISICERATINAE Basse, 1947

Genus TEXASIA Reeside, 1932

TEXASIA DENTATOCARINATA (Romer, 1852)

Pl. 72, figs. 1–3, 6, 7; pl. 73, figs. 1–3, 5, 6, 10; text figs. 10hpq, 11b

=*Ammonites dentatocarinatus* Römer, 1852, p. 33, pl. 1, figs. 2abc; Hill, 1901, pl. 44, figs. 3, 3a

=*Schloenbachia* (*Barroisiceras*) *dentatocarinatus* Lasswitz, 1904, p. 249; Grabau and Shimer, 1910, figs. 1502ab

=*Barroisiceras haberfellneri* (Hauer) (part) in Scott, 1927, p. 109

=*Barroisiceras dentatocarinatum* (Römer) in Adkins, 1928, p. 252; Adkins, 1933, p. 407, 453

=*Barroisiceras* (*Texasia*) *dentatocarinatum* (Römer) in Reeside, 1932, p. 15–16, pl. 3, figs. 1–10, pl. 4, figs. 1–3, pl. 5, fig. 1; Wright

(Arkell, Kummel, and Wright, 1957) p. L432
Not *Ammonites dentatocarinatus* Römer in Fritsch and Schloenbach, 1872, p. 32, pl. 16, figs. 1–3; Whitfield, 1892, pl. 41, figs. 3–4
Not *Barroisiceras dentatocarinatum* (Römer) in Weller, 1907, p. 836, pl. 101, figs. 5–6

Holotype.—Presumably at the University of Breslau. A cast of the holotype is deposited at the Bureau of Economic Geology, The University of Texas, Austin, Texas.

Specific characters.—Reeside (1932) has satisfactorily covered this species, and it seems unnecessary to repeat this material here.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
Holotype, from the cast								
75.0	23.5	46.5	22.5	2.02	6	19		25
60.0	23.5	46.0	25.0	1.84				
50.0	22.0	44.0	26.0	1.69				
40.0	22.0	48.0	30.0	1.60				
UT–19873								
65.0	26.0	43.0	22.5	1.93	9	15		24
WSA–65								
96.0	31.0	39.5	25.0	1.58	11	14		25
75.0	29.0	45.0	20.0	2.25				
50.0		44.0	20.0	2.20				

Remarks.—No individuals of *Texasia dentatocarinata* (Römer) in collections in Texas approach the size of the large individual illustrated by Reeside (1932, pl. 3, figs. 9, 10; pl. 4, fig. 3; and pl. 5, fig. 1). This species is apparently an end product of a lineage passing through *T. dartoni* Reeside, as Adkins (1933) has already shown *T. dentatocarinata* to be younger than *T. dartoni.*

Horizon and localities.—*Texasia dentatocarinata* (Römer) occurs in the zone of *Bevahites bevahensis* Collignon. According to Adkins *T. dentatocarinata* occurs in the upper Austin chalk (1933, p. 407), but on page 453 he lists it from the middle Austin chalk. Individuals known to me are from the Dessau limestone, which is the "upper" Austin chalk of Central Texas. *Texasia dentatocarinata* is said by Adkins (1933) to be Coniacian, and the species is so listed by Arkell, Kummel, and Wright (1957). This is the reason that Adkins had to list *Stantonoceras guadalupae* (Römer) from the Taylor; presumably it could not occur with *T. dentatocarinata* at New Braunfels, if the latter were Coniacian and the former Campanian. *Texasia dentatocarinata* has been collected from the same bed with *Bevahites bevahensis* Collignon, *Pseudoschloenbachia mexicana* (Renz), *Texanites shiloensis,* n. sp., *Glyptoxoceras ellisoni,* n. sp., and *Eutrephoceras campbelli* (Meek), where it is uppermost Santonian, and it ranges upward into the Dessau chalk, zone of *Submortoniceras tequesquitense,* where it will eventually be found in association with *Placenticeras guadalupae* (Römer).

T. dentatocarinata has been collected from the Dessau limestone near Sprinkle, on the Cameron Road, Travis County, and from the base of the Dessau limestone on Brushy Creek, south of Hutto, Williamson County, Texas. Specimens in the University of Texas collections include UT–186, UT–19873, WSA–65, UT–30558 (a cast of the holotype), and UT–30566. There is an additional specimen in the U. S. National Museum, U. S. G. S. Mesozoic locality 16770, which is a locality in the Austin chalk on Tequesquite Creek, Kinney County, Texas; the specimen was collected by J. A. Udden. An additional specimen, UT–14169, is from the Terlingua marl in the Study Butte area, a horizon equivalent to beds erroneously considered to be of Taylor age by Yates and Thompson (1959).

Genus PSEUDOSCHLOENBACHIA Spath, 1921

The species described below range in age from late lower Santonian to Campanian. The juvenile and the suture both indicate a *Gauthiericeras* lineage via *Barroisiceras.* Some will probably object to my extending the genus into the Santonian, but this seems the best solution until the entire problem of the genus *Pseudoschloenbachia* is in a more satisfactory condition. The sutures of all the species known to me relate *Pseudoschloenbachia* more closely to the Barroisiceratinae than to the Lenticeratinae, hence the above assignment.

PSEUDOSCHLOENBACHIA MEXICANA (Renz, 1936)

Pl 29, figs. 3, 4; pl. 30, figs. 1–7; pl. 31, figs. 1, 3–9; pl. 32, figs. 1–6; pl. 33, figs. 1–3, 5–7; pl. 44, fig. 1; text figs. 13e, 28d, 29bd

=*Schloenbachia bertrandi* Grossouvre var. *mexicana* Renz, 1936, pp. 6–8, pl. 3, figs. 1, 1a, and pl. 1, figs. 2, 2a

Holotype.—No holotype, as I can determine, was designated by Renz (1936), and this might lead to some doubt as to the validity of the species, the date of publication being later than 1932. Since Renz illustrated two individuals under this name it becomes necessary to select a holotype; I so designate the individual represented by Renz's Pl. 3, figs. 1, 1a (Renz, 1936). Renz does not tell which of these fossils is no. 4 and which is no. 5 of the Böse-Staub collection. All figures can be duplicated by material from the base of the Dessau limestone.

Specific characters.—Oligogyral, concentrumbilicate, subgradumbilicate, very narrowly sublatumbilicate to subangustumbilicate, arched and carinate intercostally, costally carinatifastigate. The whorl section is higher than wide, HF/W ranging at smaller diameters from 1.0 to 1.3 and from 1.2 to 1.5 or more at diameters of 100 to 150 mm. The intercostal section is suboval in younger forms, becoming oval at diameters of 100 mm.; the greatest intercostal width is at mid flank at the 60 mm. diameter, becoming more dorsad, until at the 100 mm. diameter, the greatest intercostal width is just ventrad of the umbilical tubercle. The costal section is quadrangular at the 50 mm. diameter, becoming trapezoidal at the 100 mm. diameter with flanks converging ventrad. The greatest costal width is at the umbilical tubercle throughout the ontogeny.

Costation is moderate, UT–19821 showing 12 primary and 11 secondary ribs at the 100 mm. diameter. At about a 165 mm. diameter Renz's individual (Pl. 3, figs. 1, 1a) shows 17 primary and 16 secondary ribs. Other individuals show a range of from 6 or 7 primary and secondary ribs at diameters of 40 or 50 mm., to the maximum of 17 primary and 16 secondary at a diameter of 165 mm., the number of ribs increasing with size. Because of a slight thickening of the rib at mid flank some individuals show a distinct biconcavity of ribs at diameters of about 100 mm., whereas others have ribs normally concave orad. The ribs are weak throughout, being weakest at mid flank, except for a local thickening of the rib in some individuals.

There are ventrolateral and umbilical tubercles, the latter bullate, the former clavate and with the ribs extending well ventrad of the ventrolateral clavae and hooking orad in a broad curve. In the earlier whorls there is a slight thickening which might be called a lateral node if sufficient imagination is supplied. In later whorls this thickening occurs at the point of bifurcation or intercalation and joins the two curves of the biconcave primary rib. The umbilical tubercle is on the umbilical wall. Costae are about twice as wide as the intercostae throughout the ontogeny, if all costae are considered. The interprimary width is considerably more than the width of the primary costae. As pointed out by Renz (1936) in earlier whorls the secondary ribs begin with the ventrolateral clavae, but on the outer whorls (beyond the 75 mm. diameter) the secondary ribs begin at mid flank.

Overlap is dorsad of mid flank, covering the mid flank thickening of the costae. Most of the individuals are from the Jonah calcarenite and the septation is poorly preserved. In BEG–20273 septation ceases at about 150 mm. and about 150° of body chamber is preserved, but it is so badly deformed as to defy description. Septation seems to cease at about 85 mm. on UT–19821. Renz describes the presence of a body chamber on one of his specimens, but does not say how much of it is present; the apertures are missing on his illustrations. UT–18123B is septate to at least the 125 mm. diameter.

The sutures are likewise difficult to reproduce, being corroded. UT–18124A shows greater solution on the dorsal side of the first lateral lobe than on the ventral side. The ventral lobe is deep, with shallow ventral saddle and with bifid auxiliary lobes; the first lateral saddle is bifid and the first lateral lobe trifid. The tubercles are not pronounced enough to alter the appearance of the sutures. The suture of UT–19821 is more complicated than that of most species of *Gauthiericeras*, approaching more the sutures of species of *Pseudoschloenbachia* and *Barroisiceras*.

Measurements of several individuals are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–7								
50.0	25.0	42.0						
UT–18123A								
100.0	21.5	44.0	30.5	1.44	12	11		23
75.0	19.5	50.0	32.5	1.53				
BEG–20273								
150.0	31.5	54.5	41.5	1.31				
125.0	25.0	40.5	31.5	1.28				
100.0	28.0	44.0	31.5	1.40				
75.0	27.5	47.5	34.5	1.36				
50.0	26.0	44.0	41.0	1.07				
40.0	27.5	46.5	46.5	1.00				
30.0	26.5	48.5	45.0	1.07				
UT–18124A								
65.0	24.5	47.0	32.0	1.47				
40.0	22.5	42.5	30.0	1.41				
UT–18123E								
125.0	26.5	45.5	28.0	1.62				
100.0	26.5	44.5	31.0	1.43	12	11		23
75.0	27.5	43.5	32.5	1.34				
UT–18124C								
135.0	29.0	36.0	28.0	1.28				
100.0	27.5	41.5	32.0	1.28				
Renz, Pl. 1, fig. 2								
75.0	30.0	39.5	39.0	1.10	9	9		18
60.0	31.0	42.5			7	?		?
50.0	30.0	42.0	42.0	1.00	7	?		?
40.0	27.5	39.0			6	?		?
UT–18121								
70.0	26.5	43.0	38.5	1.12	10	10		20
50.0	24.0	44.0	45.0	0.98				
35.0	24.0	50.0	47.0	1.06				
Holotype from Renz's figures								
150.0	32.0	39.0						
100.0	33.5	42.0	37.5	1.12				
UT–19821								
100.0	27.0	44.0	33.0	1.35	12	11		23
75.0	25.5	40.0	33.5	1.20				
60.0	25.0	41.5	35.0	1.19				
WSA–66								
86.0	21.0	42.0	28.5	1.47	13	11		24

D	U	HF	W	HF/W	P	S	B	T
50.0	24.0	46.0	26.0	1.77	(crushed ?)			
40.0	23.5	46.5		..				
WSA–67								
109.0	26.0	46.5	30.0	1.55	13	14		27
75.0	24.0	43.5	30.0	1.45				
53.0	27.5	43.0	35.0	1.23				
WSA–68								
120.0	30.5	40.0	37.5	1.07	14	15		29
100.0	30.5	41.0	36.0	1.14				
75.0	26.5	38.0	26.5	1.42				
WSA–70								
79.0	26.5	48.0	35.5	1.35	9	13		22
50.0	25.0	44.0	34.0	1.29				
WSA–260–261								
140.0	33.0	46.5	39.5	1.18				
100.0		43.0	36.0	1.19	10	11		21
75.0		44.0	41.0	1.07	9	10		19
60.0		43.5	43.5	1.00				
50.0		44.0	42.0	1.05				
40.0		42.5	42.5	1.00				
30.0		50.0	50.0	1.00				
WSA–264								
90.0	27.0	36.0			8	11		19

Remarks.—The juveniles of *Pseudoschloenbachia mexicana* (Renz) are gauthiericerine in shape, much like larger *G. margae*, but with fewer costae. I have removed Renz's form from subspecific category as a subspecies of Grossouvre's (1894) "*Schloenbachia*" *bertrandi*, but Renz's species may well be a geographic subspecies of some of the South African or European forms. Whether Grossouvre's species is derived from a barroisicerine lineage or not I cannot decide from the illustrations. The age of Renz's species is not greatly different from that of Grossouvre's, ranging through the Upper Santonian, and perhaps first appearing in the late Lower Santonian.

Grossouvre's specimens of "*Schloenbachia*" *bertrandi* show only a few uneven serrations on the keel (Grossouvre, 1894, Pl. 29, figs. 6ab, and Pl. 38, fig. 1) and these could be interpreted as accidental weathering. However, some serration occurs on intermediate sizes in *Pseudoschloenbachia mexicana* (75 mm. to 100 mm. or 125 mm. diameters), but the juveniles are keeled and non-serrate, and also serration disappears on the adult. "*Schloenbachia*" *flicki* Pervinquiere (1910) is much more coarsely costate at larger diameters than is *Pseudoschloenbachia mexicana* (Renz).

The Barroisicerine (or Lenticerine, if *Pseudoschloenbachia* is assigned thereto) lineage is polyphyletic, because *Pseudoschloenbachia,* as now used, is polyphyletic, even if one excludes "*Schloenbachia*" *glabra* Spath. The lineages of the Coniacian and Campanian species are different.

The juvenile specimens described in the following pages are most likely juveniles of this species, but it is not definite. There is a superficial similarity in ornamentation at comparable diameters to *Dordiella bakundu* Reyment (1957), but the similarity is only superficial, the sutures being quite different.

In addition to the fossils for which measurements are listed above, 11 more specimens from The University of Texas collections are assigned to *P. mexicana* (Renz).

Horizon and localities.—Renz (1936) gives two localities for his two individuals of *Pseudoschloenbachia mexicana,* Arroyo Tecolote and Arroyo del Fresno, Coahuila, near Jiménez. However, he does not state which individual is from which locality. UT–19821 is from the *Inoceramus undulatoplicatus* zone of the Agua Fria Quadrangle, Trans-Pecos Texas (Moon, 1953); collected by C. Gardley Moon; it is probably from the upper part of the Lower Santonian. Most of the individuals of *Pseudoschloenbachia mexicana* (Renz) are from the base of the Dessau limestone (uppermost Santonian) on Brushy Creek, Williamson County, and are associated with *Texanites shiloensis,* n. sp., *Glyptoxoceras* sp., *Bevahites bevahensis* Collignon, and *Eutrephoceras campbelli* (Meek). The species is also known from the first chalk hill (Terlingua formation) west of Study Butte on the road to Terlingua, Brewster County, and from other localities in the Terlingua and Study Butte areas, Brewster County, Texas.

PSEUDOSCHLOENBACHIA sp. juv. cf. P. MEXICANA (Renz, 1936)

Pl. 30, figs. 8, 9; pl. 31, fig. 2; pl. 33, fig. 4

Remarks.—The specimen illustrated, WSA–90, is more robust and broader than are the more normal juveniles of *Pseudoschloenbachia mexicana* (Renz). Whether this is just normal variation in juveniles or this specimen is the young of another species is not known.

Horizon and localities.—WSA–90 is from the Austin group, probably from the Dessau chalk, and was found along the San Marcos–New Braunfels Highway. ½ mile south of the Hays–Comal County line, Comal County, Texas. Collector, C. W. Horton.

PSEUDOSCHLOENBACHIA CHISPAENSIS Adkins, 1929

Pl. 15, figs. 3–5, 8; pl. 75, figs. 1–4; pl. 76, figs. 1–4, 6; text figs. 10en, 11djkopi

=*Pseudoschloenbachia chispaensis* Adkins, 1929, p 210, pl. 5, figs. 5, 6

Holotype.—BEG–3009, from the San Carlos beds, from about 14 miles south of Chispa Summit on the Chispa–San Carlos Road, western Presidio County; Lower Campanian.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, widely angustumbilicate to narrowly subangustumbilicate, carinate, convexifastigate; whorl section high (HF/W is about 1.5 at diameters of 15 mm., increasing to a figure of about 2.00 at greater diameters), flanks slightly arched, greatest width at the end of the first ¼ to ⅓ of the flanks, flanks converging slightly ventrad.

Costation is fine, sinuous, and moderately dense; the costae are low and rounded in section, primary costae ending at a small bullate umbilical tubercle. The ventral ends of the costae are drawn out into long, low bullae which are almost ⅓ of the length of the flank. Depending on the position of the intercalations, sinuosity may verge on biconcavity. There may be 2 to 4 ribs per umbilical tubercle, and there are at least 3 points of intercalation.

all on the umbilical ½ of the flank. Costation usually becomes extremely weak on the first ½ of the flank. On poorly preserved individuals costation may appear to be entirely absent on the flanks or part of the flanks. There is great specific variation in the degree of effacement of costation, and poor preservation enhances this variation. There are about 33 ribs per volution at a diameter of 20 mm., and this number increases to range from 36 to 42 ribs per volution at greater diameters.

The low, long ventral bullae are so low as to hardly merit the name bulla. Small umbilical bullae are also present. There are about 6 or 7 umbilical bullae per volution to 33 to 40 ventral bullae.

UT–19816, UT–19820, UT–19888, UT–19800, BEG–3009, and many other specimens are all septate throughout. Several sutures are preserved, those on the holotype being quite magnificent. The ventral lobe is short and wide, with large subsidiary lobes. The first lateral saddle is divided symmetrically by the single subsidiary element of the next smaller grade. The first lateral lobe is about as long as, or a little longer than, the ventral saddle, and is trifid.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–19800								
20.0	17.5	47.5	30.0	1.58				32±
15.0	16.5	47.0	33.5	1.40				
UT–19813								
50.0	21.0	50.0	24.0	2.25				
40.0	20.0	47.5	23.5	2.00				
30.0	18.5	52.0	23.5	2.21				
UT–19811								
100.0	21.0	51.0	25.0	2.02				
75.0	22.0	50.0	26.5	1.87				
UT–19820								
100.0	20.5	49.0	25.0	1.95				
75.0	21.0	45.5	23.5	1.95				
60.0	19.0	44.0	21.5	1.95				
BEG–3009 (holotype)								
91.0	20.5	47.5	26.0	1.83	18	24		42
75.0	20.0	48.0	26.5	1.80				
60.0	20.0	50.0	23.5	2.14				
UT-30602								
58.0	19.0	49.0	23.5	2.06	25	10		35
40.0	19.5	51.5	23.5	2.16				

Remarks.—*Pseudoschloenbachia chispaensis* Adkins is a large species, as is *P. mexicana* (Renz), if the sizes of other illustrated species are any indication, but illustration size may not mean much since nearly all of the individuals are septate throughout. The illustrations of *P. umbulazi* (Baily) and *P. griesbachi* (Van Hoepen) are of individuals not much larger than the smallest juvenile of *P. chispaensis* in the collections that I have studied. Someday a study should be made concerning the total variation of this species. There are over a hundred specimens available. *P. chispaensis* is different from other species of the genus because it is much more densicostate.

Horizon and locality.—From the Lower Campanian of Trans-Pecos Texas. No specimen of *Pseudoschloenbachia chispaensis* Adkins has yet been collected east of the San Carlos black shale facies. In addition to the locality for the holotype, the species occurs at many other localities between the rim rock and the Rio Bravo, Presidio County, Texas. *Pseudoschloenbachia chispaensis* occurs with several species of *Placenticeras* and *Stantonoceras*, *Bevahites*, *Texanites*, and *Submortoniceras*. It certainly occupies the basal Campanian, and may extend down into the Santonian, but the vertical distribution of the species has not been thoroughly studied, as yet.

PSEUDOSCHLOENBACHIA WILSONI, n. sp.

Pl. 73, figs 7, 8, 12; pl 75, figs 5, 7, 8, 9
text figs. 10jm

Holotype.—UT–30596, from the San Carlos formation, about 6¾ miles southeast of the Colquit Ranch house, Presidio County, Texas, collected by Braithwaite and Frantzen.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, subangustumbilicate, carinate, convexifastigate. The whorl height is twice the whorl width or even greater. The intercostal flanks are slightly arched, converging slowly ventrad. The costal section is almost rectangular because of the positioning of the ventral bullae. The flanks are flat or slightly swelled in the costal section.

Costation is weak to absent, there being from 7 to 10 weak, widely spaced primary costae on the outer volution of the two larger specimens; these costae are a little stronger at the beginning of the volution than at its end. There are about 26 ventral bullae which curve forward over the ventrolateral shoulder. On the first half of the outer whorl the ventral bullae are more nodate and are developed also on the faint secondary costae which rise just dorsad of mid flank. Costae are about the same width as intercostae.

Tuberculation consists of 8 to 10 umbilical tubercles, slightly bullate, per volution, and 25 to 30 ventral bullae per volution at the ventrolateral margin. These extend dorsad for ⅓ to ½ of the flank and suddenly project orad on the venter.

All three specimens are septate throughout, but the septa are poorly preserved and could not be reproduced. The apertures of course are broken off, and overlap is to just dorsad of the umbilical tubercle.

Measurements are as follows:

D	U	HF	W	HF/W	P	S	B	T
UT–30596 (holotype)								
66 0	25.0	45.0	21.0	2.10	10	21		31
46.0	24.0	50.0	24.0	2.08				
UT–28								
60 0		58 5	26.5	2 18	9			26
50.0		56 0	28.0	2 00				
40 0		57.4	25.0	2.30				
UT–19801								
43 0	16 5	53 5	27.0	2 00				30±
30 0		48 5	30.0	1.61				

Remarks.—*Pseudoschloenbachia wilsoni*, n. sp., is more sparsicostate than is *P. chispaensis* Adkins, and the ventrolateral tubercles are less bullate and higher, being of quite different form. UT–28 is not nearly so strongly costate as UT–30596, but I believe this is specific variation enhanced by poorer preservation of UT–28.

Horizon and localities.—In addition to the holotype, for which the locality is given above, UT–28 is from the base of the Dessau limestone, Ray's Bluff, Brushy Creek, Travis County; it is probably the base of the Campanian or the top of the Santonian. UT–19801 is from near the old San Carlos coal mine, Presidio County, collected by Dumble and Cummins, 1892.

PSEUDOSCHLOENBACHIA sp.

Pl. 73, figs. 4, 11; pl 75, fig. 6

A fragment of what appears to be the body chamber of a *Pseudoschloenbachia* is from the upper Boquillas–Terlingua unit of Moon (1953). The individual has a typical pseudoschloenbachiine whorl section. slightly sigmoid ribs with low. rounded umbilical and ventrolateral bullae. This fossil has undergone solution of the carbonate internal mold, and the costae may not be effaced as much as they appear to be. The keel is high, and appears to be slightly serrate, as in *Texasia dartoni* Reeside, *Pseudoschloenbachia mexicana* (Renz), etc.

Remarks.—At this point it might be apropos to discuss the relationships, if any, of *Pseudoschloenbachia, Muniericeras,* and *Texasia.* The costae on the venter of *Barroisiceras s. s.* are only slightly projected if projected at all. The development of the ventrolateral clavae into projected ventrolateral bullae in the adult of *Pseudoschloenbachia mexicana* and in "*Schloenbachia*" *bertrandi* Grossouvre seems to be the primary means of distinguishing these species from *Texasia dartoni* (Reeside), in which the ventrolateral clavae become projected tubercles only on the last few ribs of the largest individuals, and in which the keel remains serrate to diameters beyond 150 mm. It is no great step then from the older *Texasia dartoni* to *Pseudoschloenbachia mexicana,* nor from the latter to other of the pseudoschloenbachiines. Obviously, then, there is something wrong with the terminology, but *Texasia dartoni* is such a rare species that it has been extremely difficult to work with. "*Schloenbachia*" *fournieri* Grossouvre, likewise, is not greatly different from some of these, but is probably older than "*Schloenbachia*" *bertrandi.* If there is a barroisiceratine lineage leading to *Pseudoschloenbachia,* and the pseudoschloenbachiine suture would certainly affirm such a lineage, then the older lineage of *Pseudoschloenbachia boreaui* (Grossouvre) had already appeared prior to the appearance of its homeomorph in the *Texasia* lineage.

This discussion should not be terminated without some remarks concerning *Munier-iceras* Grossouvre. If the costation were reduced, or partially effaced and the suture not available, it would be almost impossible to tell *Muniericeras* from similar *Pseudo-schloenbachia.* Just such a *Muniericeras* is *M. twiningi,* n. sp., described above. Some specimens classified as pseudoschloenbachiines have a serrate keel. If these were derived from a barroisiceratine lineage, they should not be included in *Pseudo-schloenbachia.* The problem here is to separate *Pseudoschloenbachia*-like barroisiceratines descended from *Texasia* from muniericeratines with reduced or partially effaced costation, and separate these in turn from true pseudoschloenbachiines.

Horizon and locality.—*Pseudoschloen-bachia,* n. sp., is from 10 feet above the *Inoceramus undulatoplicatus* bed and about 80 feet below the base of the Tertiary conglomerate, 4.7 miles west of the Clanton Ranch house, Agua Fria Quadrangle, Brewster County, Trans-Pecos Texas. Collected by W. S. Adkins and John T. Twining.

Subfamily LENTICERATINAE Hyatt, 1900

Genus EULOPHOCERAS Hyatt, 1903

EULOPHOCERAS WOLLMANAE, n. sp.

Pl 72, fig. 5; pl 74, figs. 1, 3–6, text figs. 11cgms

Holotype.—The larger specimen from Miss Wollman's collection, illustrated in this work on pl. 72, fig. 5, and pl. 74, figs. 3 and 5, from just below the middle of the Dessau limestone, Williamson Creek, Travis County, Texas; collected by Miss Wollman.

Specific characters.—Oligogyral, occlusal, fastigate with arched flanks, perangustumbilicate. The height is greater than the width, HF/W ranging from 1.75 to 2.05, increasing with diameter. The internal mold is discoid, and smooth throughout. The venter is sharp, and the body chamber is not preserved on either of the two specimens extant.

The suture is paralenticerine, particularly in the larger individual (the holotype). The ventral saddle is almost lacking on the ventral lobe. The first lateral saddle is wide, and most stretching or lengthening of the suture with increased extension of the flank seems to occur in this saddle: it is divided by a short acanthocerine secondary lobe. The first lateral lobe is extremely long, extending below the ventral lobe by the full length of the ventral lobe, and even the first subsidiary lobe of the suspensive lobe extends well below the ventral lobe. The second lateral saddle is narrow, on the order of the first lateral lobe. The suture is not greatly diverticulate, but the soft, chalky steinkern has suffered some erosion. The suture of the smaller individual has a shorter and wider first lateral lobe, but the sutures are not sufficiently well preserved for an ontogenetic study.

Measurements of the two specimens in Miss Wollman's collection are:

D	U	HF	W	HF/W
larger (holotype)				
140.0	02.0	57.0	28.0	2.05
100.0		59.0	29.0	2.05
75.0		58.5	28.0	2.10
smaller				
70.0	02.9	60.0	34.5	1.75
50.0	00.5	62.0	34.0	1.80
34.0	00.0	62.0	33.0	1.90

Remarks.—I have not been able to solve the problem of the suture in *Eulophoceras wollmanae,* n. sp. Certainly there may be great variations in sutures of the same species, or individual, for that matter. especially in the Lenticeratinae. However. the sutures of *E. wollmanae,* n. sp., do not greatly resemble those of *E. natalense* Hyatt or *E. jacobi* Hourcq. *E. wollmanae* is not as high-whorled as either *E. natalense* or *E. jacobi.*

Horizon and locality.—The second. smaller individual collected by Miss Wollman is from the same bed and locality as the holotype, occurring in the Lower Campanian zone of *Submortoniceras teques-*

quitense with *S. tequesquitense* n. sp., *Stantonoceras guadalupae* (Römer), and *Australiella pattoni* n. sp.

Family SPHENODISCIDAE Hyatt, 1900

Genus MANAMBOLITES Hourcq, 1949

MANAMBOLITES RICENSIS, n. sp.

Pl. 2, figs. 14, 16, 19; pl. 72, fig. 4; pl. 74, fig. 2; text figs. 8f, 9mp, 11h

=*Sphenodiscus* cf. *lenticularis* in Adkins, 1933, p. 497, as reported by Whitney

?=*Sphenodiscus,* Stephenson, 1941, p. 20, 23

Holotype.—UT–10948, from the *Nostoceras* zone in Williamson County, Texas, at Rice's Crossing of Brushy Creek.

Specific characters.—Oligogyral, occlusal, craterumbilicate, perangustumbilicate, fastigate in early whorls, the venter becoming rounded beyond the 75 mm. diameter. The whorl section is lanceolate to about the 75 mm. diameter, becoming more elliptical at greater diameters. The greatest width is just dorsad of mid flank at all stages.

There is no ornamentation, the phragmacone and body chamber being perfectly smooth at all stages. The outer layers of shell have flaked off, so that even the growth lines do not appear. The shell is extremely thin, probably 0.5 mm. thick or less.

The holotype is septate to a diameter of 60 mm., and the body chamber originally consisted of more than 120° of volution, but the aperture has been lost. UT–32582 is septate throughout, and UT–988 is a fragment containing part of the phragmacone and a part of the body chamber.

The suture is paralenticerine, with two adventitious lobes ventrad of the first lateral lobes, and with wide and short ventral lobe; there are about three lateral lobes dorsad of the first lateral lobe, but still retained in the external suture. The suture is moderately diverticulate.

Measurements are as follows:

D	U	HF	W	HF/W
UT–10948				
81.5	00.0	60.0	28.5	2.10
63.5	00.0	56.0	20.5	2.71
44.0	00.0	59.0	20.5	2.87

Remarks.—*Manambolites ricensis,* n. sp., is an enigma. It should be a *Paralenticeras,* but after all it is from the top of Campanian, associated with several species of *Nostoceras,* the youngest species of *Placenticeras, Menuites stephensoni,* n. sp., and all from above the *Bostrychoceras* zone. However, the suture is distinctly paralenticerine to and including the two adventitious lobes, but the more ventrad of the adventitious lobes is underdeveloped. *Manambolites ricensis* probably represents a transitional species from *Manambolites* to *Sphenodiscus.* The saddles are not typically arched and rounded as in more typical species of *Sphenodiscus* or *Manambolites.*

The holotype is the individual reported by Whitney as *Sphenodiscus* cf. *lenticularis* in Adkins (1933, p. 497). It is quite likely that the unidentifiable individuals of *Sphenodiscus* reported by Stephenson (1941, p. 20, 23) belong to this or some similar species. I examined the casts of these in the U. S. National Museum, but preservation was too poor for a definite decision.

Horizon and locality.—UT–10948, the holotype of *Manambolites ricensis,* n. sp., is from the *Nostoceras* zone at Rice's Crossing of Brushy Creek, Williamson County. UT–32582 is from the same zone at Sandahl's farm, just southeast of the New Sweden church, Travis County, and, although UT–988 retains no locality information, it also is probably from Sandahl's farm. I can find no mention of the Rice's Crossing locality or the Sandahl farm locality in Stephenson (1941). Adkins knew of these localities (1933, p. 497–498) and discussed them under the Navarro Group, Kemp formation. This was before the Corsicana formation had been named. Stephenson apparently did not know about them, or was not given the opportunity to study the fossils which W. A. Bramlette (1934) used for a master's thesis at The University of Texas. The fauna from Rice's Crossing and the Sandahl farm needs monographing to determine if it is a facies of the Nacatoch formation, or an attenuated tongue of the Neylandville, or an extension of the upper Taylor.

Manambolites ricensis, n. sp., is associated with *Menuites stephensoni*, n. sp., *Placenticeras intercalare* Meek, *Solenoceras* sp., *Nostoceras* spp., *Eutrephoceras* sp., and other molluscs. The fauna appears to represent the top of the Campanian.

Class PELECYPODA

Order ANISOMYARIA

Superfamily PTERIACEAE

Family PERNIDAE Zittel

Genus INOCERAMUS Sowerby, 1814

INOCERAMUS UNDULATOPLICATUS Romer, 1852

Pl. 81, figs. 1–3; pl. 82, figs. 1–4

=*Inoceramus undulato-plicatus* Römer, 1852, p. 59, pl 7, fig. 1; Hill and Vaughan, 1898, pl 50, fig. 3; Deussen, 1924, pl. 7, fig. 3; Adkins, 1928, p. 33; Shimer and Shrock, 1944, pl. 151, fig. 2; Young and Marks, 1952, pl. 1, fig. 11

doubtfully *I. undulatoplicatus* Whiteaves, 1879, pl. 20, figs. 2, 2a

Remarks.—Many of Römer's (1852) illustrations leave much to be desired (e.g. compare his pl. 3, figs. 1a–d of the holotype of *Texanites texanus* with the illustration of the holotype in this work). As I interpret this species there is considerable variation, but not sufficient to include the small individuals illustrated by Whiteaves (1879, pl. 20, figs. 2, 2a); in these individuals the plications are nearly paired, and the Texas examples of Römer's species show no pairing of plications. In addition the Whiteaves specimens are not large enough to show the strong concentric undulations.

The greatest variation, in my interpretation, is in the growth stage at which the strong marginal undulations appear. UT-30691 (pl. 81, figs. 2, 3) shows such large undulations at a somewhat younger stage than does UT-30719 (pl. 82, figs. 1–4), which is a larger specimen with the periphery broken off. Adkins (1933) referred those forms typified by pl. 82, figs. 1–4, to *I. digitatus* Sowerby.

Locality and horizons.—*Inoceramus undulatoplicatus* Römer is from the upper part of formation B (=middle Austin chalk, *auctorum*, Central Texas) in Central Texas, and is particularly abundant near Walburg, Williamson County. Although it ranges through the zones of *Texanites stangeri densicostus* (Spath) and *Texanites texanus texanus* (Römer), it is particularly abundant in the chalky beds just below the zone of *T. texanus texanus*. I have no ammonites from the Big Bend locality, but Moon (1953) collected late lower Santonian ammonites from his *Inoceramus undulatoplicatus* beds. In Central Texas *Inoceramus undulatoplicatus* occurs with *Texanites texanus texanus* (Römer), and *T. stangeri densicostus* (Spath).

Superfamily OSTRACEAE

Family OSTREIDAE Lamarck

Genus LOPHA Roding, 1798

LOPHA TRAVISANA (Stephenson, 1936)

Pl. 77, figs. 1, 4

=*Ostrea diluviana* Linné in White, 1884, pl. 40, fig. 1, pl. 41, figs. 1, 2; Cragin, 1893, p. 203

=*Ostrea* sp. cf. *diluviana* Linné in Deussen, 1924, pl. 10, fig. 1

=*Ostrea* (*Alectryonia*) *diluviana* Linné in Hill and Vaughan, 1898, pl. 57, fig. 1; Hill and Vaughan, 1902, fig. 42

=*Ostrea* (*Alectryonia*) *diluviana* LaMarck in Hill, 1901, Pl. 45, fig. 2

=*Ostrea travisana* Stephenson, 1936, pl. 3, figs. 1–5; Young and Marks, 1952, pl. 1, fig. 12

Remarks.—Stephenson's (1936) description is adequate for the species, but if large samples of *O. travisana* Stephenson, *O. diluviana* Linné, and *O. santonensis* d'Orbigny were compared, I think it would be difficult to separate them on morphology alone. By popular designation of Roy T. Hazzard and others this species has become known as "old snaggletooth."

Horizon and localities.—As pointed out by Young and Marks (1952) *Lopha travisana* (Stephenson) ranges through the upper Austin chalk (Dessau limestone and upper Jonah calcarenite) and the Burditt marl. The specimens from the more calcarenitic beds are heavier and more ovate. The age is latest Santonian and Lower Campanian. The lowest occurrence is with *Bevahites bevahensis* Collignon, *Glyptoxoceras ellisoni*, n. sp., *Texasia dentatocari-*

nata (Römer), *Texanites shiloensis* Young, and the highest occurrence, only in central Texas, is well up in the zone of *Delawarella delawarensis* (Morton). The holotype is from the latter horizon.

Genus PYCNODONTE Fischer de Waldheim, 1835

PYCNODONTE AUCELLA (Romer, 1852)

Pl. 21, figs. 5, 8; pl. 22, fig. 3; pl. 78, fig. 7; pl. 79, figs. 2, 6

=*Ostrea vesicularis* LaMarck var. *aucella* Römer, 1852, pl. 9, figs. 4a, 4b

=*Gryphaea aucella* Römer, Hill and Vaughan, 1898, pl. 60, figs. 2ab; Hill, 1901, pl. 45, figs. 4, 4a; Hill and Vaughan, 1902, fig. 44; Deussen, 1924, pl. 7, figs. 2, 2a; Young and Marks, 1952, pl. 1, fig. 8

=?*Gryphaea pitcheri* Conrad, 1857, p. 155 (*pro parte*), pl. 21, figs. 3a–c only

=*Gryphea aucella* Römer in Adkins, 1928, p 108

=*Gryphea* cfr. *newberryi* Stanton in Adkins, 1928, p. 109

=*Gryphaea newberryi* (?) Eifler, 1951, p. 342

=*Gryphaea wratheri* Stephenson, 1936, pl. 1, figs. 1–4; Shimer and Shrock, 1944, pl. 155, figs. 20, 21; Young and Marks, 1952, pp. 477, 478, 480–83, 486

Remarks.—*Pycnodonte aucella* (Römer, 1852) and *Pycnodonte wratheri* (Stephenson, 1936) are different morphotypes of the same sequence of shells, occurring together or separately, depending on the environment. There is reason to believe that the *P.* "*wratheri*" morphotype was adapted to softer bottoms, and that the typical *P. aucella* was adapted to harder (higher energy) bottom environments. Certainly the *P.* "*wratheri*" morphotype is more typical of the lime mud environments and Römer's form more typical of calcarenite deposits. The so-called "*G.*" cfr. *newberryi* (Adkins, 1928, p. 109, and Eifler, 1951, p. 342) of Trans-Pecos Texas is a *P. aucella* in beds representing a mud environment, and differs little if any from Stephenson's *P.* "*wratheri.*" Unfortunately Römer's type was a small specimen, though not juvenile; this has misled several writers. In Trans-Pecos Texas there is a gradation to *Pycnodonte convexa* Morton. Conrad (1857) apparently considered "*G.*" *aucella* (Römer) a synonym of the variety *navia* of Morton's *G. pitcheri,* and he appears to have illustrated *P. aucella* (Römer) instead of typical *G.* "*pitcheri*" Morton.

Localities and horizons.—*Pycnodonte aucella* Römer occurs in the Austin chalk wherever the environment was right. The oldest occurrence known to me is in Williamson County, from the top of formation A (probably Upper Coniacian), and the species ranges upward into the Burditt marl (Lower Campanian) in Travis County, where a rash of juvenile specimens can be found, but very few adults. In the Davis Mountains, along the northeast front, *P. aucella* occurs with Lower Campanian fossils, and it has also been collected in the San Carlos area, also from Campanian rocks.

PYCNODONTE CONVEXA (Say, 1820)

Pl. 78, fig. 4; pl. 80, fig. 2

=*Ostrea convexa* Say, 1820, p. 42

=*Gryphaea convexa* Morton, 1829, pl. 4, figs. 1, 2; Morton, 1830, p. 283; Morton, 1834, pl. 4, figs. 1, 2; Troost, 1840, p. 46; Weller, pl. 44, figs. 1, 2; Grabau and Shimer, 1910, fig. 629; Stephenson and Monroe, 1940, pl. 5, figs. 8–10; Shimer and Shrock, 1944, pl. 155, figs. 20, 21; Richards, 1958, pp. 114, 115, pl. 19, figs. 7, 8

Locality and horizon.—*Pycnodonte convexa* Morton is rare in Texas, but has been collected from Lower Campanian zones in the northeast front of the Davis Mountains and from Lower Campanian zones in the San Carlos area, Trans-Pecos Texas. This agrees well with its Lower Campanian occurrence in the Tombigbee sandstone of Alabama (Stephenson and Monroe, 1940).

Genus EXOGYRA Say, 1820

EXOGYRA PONDEROSA Romer, 1852, s. l.

EXOGYRA PONDEROSA ERRATICOSTATA Stephenson, 1914

Pl. 77, fig. 6; pl. 78, figs. 1, 8; pl. 79, fig. 4

=*Exogyra ponderosa* Weller, 1907, pp. 460–462 (*pro parte*, not fig. 2)

=*Exogyra ponderosa erraticostata* Stephenson, 1914, pp. 49–50, pl. 15, fig. 4, and pl. 16, figs. 1, 2; Stephenson, 1923, pp. 171–173, pl. 47, fig. 1; Stephenson, 1936, p. 375, pl. 1, fig. 10; Richards 1958, pp. 116–117, pl. 20, fig. 2

Holotype.—USNM-31225, from the

base of the Selma chalk, 1 mile west of Cotton Gin Port, Monroe County, Mississippi (Stephenson, 1923).

Remarks.—As Stephenson (1914) has pointed out, there are all gradations from *Exogyra ponderosa ponderosa* Römer to *E. ponderosa erraticostata* Stephenson. It should be added that there are likewise all variations from *Exogyra ponderosa ponderosa* to *E. upatoiensis* Stephenson, and likewise from *E. upatoiensis* to *E. ponderosa erraticostata.* I would like to recommend that *Exogyra ponderosa* Römer, s. l., be considered to be composed of the three subspecies, *E. ponderosa ponderosa* Römer, *E. ponderosa upatoiensis* Stephenson, and *E. ponderosa erraticostata* Stephenson. Species of *E. ponderosa upatoiensis* like the one illustrated by Dane (1929, pl. 9, fig. 2) are more coarsely costate than typical *E. ponderosa upatoiensis* (Stephenson, 1924, pl. 45, figs. 1–5) and lead to even more coarsely costate forms of *E. ponderosa upatoiensis* like UT–30724 (this work, pl. 77, figs. 2 and 3), in which the fine costation extends further down the umbones than on typical *E. ponderosa erraticostata* and in which the costation is extremely variable in width on the adult shell. These in turn lead to forms like UT–1722B (this work, pl. 78, fig. 3) with scattered large costae and fine costation well down the umbones, and these in turn to more typical forms of *E. ponderosa erraticostata* such as those illustrated by Stephenson (1914, pl. 15, fig. 4) and this work (pl. 77, fig. 6). Morphic types of *E. ponderosa upatoiensis* (this work, pl. 77, fig. 5) might better be placed in *E. ponderosa ponderosa*, except that this particular individual is the most "ponderosa"-like form from a sample of a supply of *E. ponderosa upatoiensis.*

I see no reason for breaking such morphologic clines until the exact stratigraphic value of the different morphic types is known. The morphic types of *E. ponderosa,* s. l. are:

A. *Exogyra ponderosa upatoiensis* Stephenson

1. Small and finely costate—typical *E. ponderosa upatoiensis* Stephenson.
2. Larger forms with slightly coarser costae—*E. ponderosa upatoiensis* similar to the *E. "ponderosa"* of Dane (1929, pl. 9, fig. 2 only).
3. Forms in which a few large costae are intercalated with costae of the size of no. 2 above—*E. ponderosa upatoiensis* (this work, pl. 77, figs. 2 and 3); the costae extend further down the umbones than in typical *E. ponderosa erraticostata.*

B. *E. ponderosa erraticostata* Stephenson

4. Forms typically erraticostate and equidimensional—*Exogyra ponderosa erraticostata* (Stephenson, 1914, pl. 15, fig. 4).
5. Forms typically erraticostate and higher than long—*E. ponderosa erraticostata* (Stephenson, 1914, pl. 16, figs. 1 and 2, the holotype, and this work, pl. 77, fig. 6).
6. Forms equidimensional as in 4 above, but with more dense costae, apparently leading to forms of *E. cancellata* Stephenson, but still retaining fine ribbing on the first 1 or 2 cm. of the umbones, reminiscent of *E. upatoiensis*—*E. ponderosa erraticostata* (this work, pl. 78, figs. 1 and 8).
7. Forms which have practically no costae and morphologically are close to *E. ponderosa ponderosa* Römer, but are thinner shelled—*E. ponderosa erraticostata* (this work, pl. 77, fig. 6).

C. *Exogyra ponderosa ponderosa* Römer

8. Typical *Exogyra ponderosa ponderosa* Römer, with the only costation being fine "upatoiensis"-type costation restricted to the very early part of the beaks and umbones—*E. ponderosa ponderosa* (Stephenson, 1914, pl. 13, figs. 5–7 and pl. 14).
9. Forms with sharper umbones and flatter bases to the left valves. These are *Exogyra* n. sp. of Böse (1919) and *E. ponderosa,* Austin chalk variety, of Adkins (1933). This form

does not have the small ribs on the first 1 or 2 cm. of the beak and with its large attachment scar seems to be adapted to an area with harder bottom. Apparently Böse (1919) and Adkins (1933) followed Stephenson's (1914) interpretation, considering the holotype to belong to type 8. However the figure of Adkins (1928, pl. 36, fig. 1) indicates a large attachment scar, as does the figure of Römer (1852, pl. 9, figs. 2ab). Römer's figures also show some costae, but there is no crenulation of the edges on the photograph of the Adkins (*op. cit.*) figure, as there is in Römer's drawing (*op. cit.*) and the drawing may be in error. Apparently the holotype has never been designated. The Römer collection needs revisiting before such a selection is made, but both the specimen illustrated by Römer and the one illustrated by Adkins are from the Austin chalk and belong to type 9.

None of the 9 types can yet be separated stratigraphically, except that typical *E. ponderosa erraticostata* have been recorded higher (Pecan Gap chalk of Central Texas, pl. 77, fig. 6) than any of the other types except type 8, *Exogyra ponderosa ponderosa*. Types 1–5 are not known to occur above the zone of *Delawarella delawarensis*. Type 7 extends into the zone of *Hoplitoplacenticeras vari*, and type 8 extends through the zone of *Hoplitoplacenticeras vari*. Yates and Thompson (1959) quote Stephenson as referring a specimen of *Exogyra erraticostata* from the Terlingua formation as being late Taylor (?) in age, but the ammonite evidence for the age of these beds is uppermost Austin or at highest, lowest Taylor.

Horizons and localities.—Stephenson (1914, 1923) lists many of the localities and horizons. In Texas *Exogyra ponderosa erraticostata* Stephenson is known from the Pecan Gap chalk, from marls above the Boquillas formation on the northeast flank of the Davis Mountains, and from the San Carlos beds, Brewster County, the latter locality also recorded by Stephenson (1914).

EXOGYRA PONDEROSA UPATOIENSIS Stephenson, 1914

Pl. 77, figs. 2, 3, 5; pl. 78, figs. 3, 5; pl. 80, fig. 1

=*Exogyra costata* Udden, 1907, p. 36
=*Exogyra ponderosa* var. Dane, 1929, pl. 9, fig. 2
=*Exogyra upatoiensis* Stephenson, 1914, pl. 13, figs. 1–4; Stephenson, 1923, pl. 45, figs. 1–5; Stephenson, 1956, pl. 43, figs. 6–10

Horizon and localities.—In addition to those listed by Stephenson (1914, 1923) and Dane (1929, pl. 9, fig. 2), *Exogyra ponderosa upatoiensis* Stephenson is known from Lower Campanian beds in the San Carlos area, Presidio County, and from the northeast front of the Davis Mountains, Trans-Pecos Texas.

EXOGYRA PONDEROSA PONDEROSA Romer, 1852

Synonymy.—For early synonymy see Stephenson (1923, p. 165–166).

Additional synonymy.—

=*Exogyra ponderosa* Römer in Böse, 1913, pl. 9, figs. 1, 2; Deussen, 1924, pl. 10, figs 3, 3a; Adkins, 1928, pl. 36, fig. 1; Calahan, 1939, pl. 4, figs. 1–4, pl. 5, fig. 1; Stephenson and Monroe, 1940, pl. 4, fig. 2; Shimer and Shrock, 1944, pl. 156, figs. 9, 10, and pl. 157, fig. 1; Young and Marks, 1952, pl. 1, fig. 6

Horizon and localities.—Stephenson (1914, 1923, 1933) has adequately covered the distribution of *Exogyra ponderosa ponderosa* Römer. With its earliest appearance in the Tombigbee sandstone of Alabama, in the Ozan and in the lower Brownstown of Arkansas and adjacent northeast Texas, and in the base of the Dessau in central Texas, it seems always to be associated with *Bevahites bevahensis* Collignon, *Texanites shiloensis* Young, *Texanites roemeri* (Yabe and Shimizu), and other fossils that represent either the top of the Santonian or the base of the Campanian. From the zone of *Bevahites bevahensis*, *Exogyra ponderosa ponderosa* ranges up through the lower zone of the Upper Campanian, the zone of *Hoplitoplacenticeras vari*.

EXOGYRA LAEVIUSCULA Römer, 1852

=*Exogyra laeviuscula* Römer, 1852, pl. 9, figs. 3a–c; Conrad, 1857, pl. 7, figs. 4ab; White, 1875, pl. 17, figs. 2a–d; White, 1884, pl. 52, figs. 3–5; Stanton, 1893, pl. 8, figs. 5, 6; Hill and Vaughan, 1898, pl 62, figs. 2ab; Hill, 1901, pl. 45, fig. 3; Hill and Vaughan, 1902, fig. 43; Grabau and Shimer, 1910, fig. 4d; Deussen, 1924, pl. 10, figs. 2, 2a; Shimer and Shrock, 1944, pl. 156, figs. 4, 5; Young and Marks, pl. 1, fig. 5

Horizon and localities.—At the type locality in central Texas *Exogyra laeviuscula* Römer is Lower Campanian, occurring near the top of the zone of *Submortoniceras tequesquitense* Young. In addition to the distribution given by Stephenson (1937), *E. laeviuscula* is also known from the Lower Campanian beds on the northeast front of the Davis Mountains, Trans-Pecos Texas.

Order EULAMELLIBRANCHIA

Superfamily VENERACEAE

Family VENERIDAE Gray

Genus CYPRIMERIA Conrad, 1864

CYPRIMERIA RODDAI, n. sp.

Pl. 79, figs. 1, 3, 5

=*Cyprimeria* sp. cf. *alta* Conrad in Adkins, 1928, p. 163, (*pro parte*), e.g. "at San Carlos" only

Holotype.—UT–19886, from the sandy member of the San Carlos formation (=*Cardium* bed), Porvenir area, Presidio County, Trans-Pecos Texas; collected by Wayne Miller.

Specific characters.—The shell is of medium size, broadly ovate in outline, only a little longer than high, with considerable variation in the height-length ratio (1.05–1.20). The shell is depressed convex, inequivalve, slightly gaping at each end, with small, flattish beaks barely rising above the hinge area, prosogyrate; beaks positioned approximately ¼ of the length from the anterior end. An umbonal ridge is wanting and there is no discernible difference in shape between the two valves. Dentition consists of three cardinal teeth on each valve, and lateral teeth are wanting, although the overhang of the shell forms a faint ridge posterodorsally along the outer margin of the hinge. The cardinal teeth on the left valve consist of a narrow, slightly curved, oblique posterior tooth; a broad middle cardinal bearing a faint ridge along each edge; and a shorter anterior cardinal of moderate width. The middle cardinal of the right valve is not as wide as the comparable tooth on the left, and it slopes posteriorly into the broad socket which receives the middle tooth of the left valve. The anterior and posterior cardinals of the right valve are similar in shape to their namesakes in the left valve. The ligamental groove is short and not deep. A lunule is not discernible, and the excavated area back of the beaks is deep and wide. Except for the slightly drawn out posterior margin the outline of the shell is almost circular.

Measurements are as follows:

H	L	T	L/H
UT–30427A			
56.0	65.0	14.0	1.19
UT–30427B			
67.0	72.5	16.0	1.08
UT–30427C			
68.0	73.0	18.5	1.07
UT–19885			
65.0	74.0	19.0	1.14
UT–19886 (holotype)			
68.0	77.0	18.0	1.13
UT–30428A			
65.0	75.0?	16 0	1.16
UT–30428B			
67.0	72.0	16.0	1.07

Remarks.—UT–30427A has been drilled by an oyster-drill. *Cyprimeria roddai*, n. sp., is similar to and perhaps an offshoot from the progenitor of *Cyprimeria alta* (Conrad). It differs from *C. alta* in the lack of discernible lunule or escutcheon, and in the consistently much more massive middle cardinal. It differs from *Cyprimeria coonensis* Stephenson (=*C. alta* Wade *non* Conrad, Wade, 1926, pl. 29, figs. 2–4, and pl. 30, figs. 1, 8) in that *C. coonensis* posseses a distinct umbonal ridge which, continuing to the margin of the shell, produces a ventro-posterior salient; this is absent in *C. roddai.* In *C. coonensis* the excavation posterior to the beaks is not nearly so deep as in *C. roddai. C. alta* Conrad (Stephenson and Monroe, 1940, pl. 12, figs. 3, 4) does not have the deep excavation posterior to the beaks which Stephenson (1941) considers so typical of that species. The hinge margins are much more acute and flattened in *C. roddai* than in *C. gabbi,* and the cardinal teeth in *C. gabbi* are not nearly so broad and massive. *C. cretacea* (Conrad), *C. densata* (Conrad), and *C. depressa* (Conrad) are all much smaller and have a much longer shell in relation to height than is found in *C. roddai. C. ovata* (Meek and Hayden), *C. excavata* (Morton), and *C. major* Gardner do not possess the excavated area back of the beaks that is so typical of *C. roddai.* Other North American species are not nearly as circular in outline as *C. roddai,* and *Cyprimeria "lens"* Whiteaves (1879) has sharper growth lines and lamellae.

Horizon and localities.—Cyprimeria roddai, n. sp., has been collected from the San Carlos beds at many localities below the rim rock between Chispa Summit and the Rio Grande River. There are 15 or 20 specimens at the Geology Department, The University of Texas, several in the Bureau of Economic Geology, and the individuals in the Adkins collection have not yet been catalogued. *C. roddai* is Lower Campanian, from the zone of *Submortoniceras candelariae.*

REFERENCES

ADKINS, W. S., 1928, Handbook of Texas Cretaceous fossils: Univ. of Texas bull. 2838, 385 pp. 37 pls.

———, 1929, Some Upper Cretaceous Taylor ammonites from Texas: Univ. of Texas bull. 2901, pp. 203–211, pls. 5, 6.

———, 1931, Some Upper Cretaceous ammonites in western Texas: Univ. Texas bull. 3101, pp. 35–72, 2 text figs., 4 pls.

———, 1933, Mesozoic Systems in Texas, *in* Sellards, Adkins, and Plummer, The Geology of Texas, vol. 1, Stratigraphy: Univ. of Texas bull. 3232, pp. 240–518, figs. 13–27.

ANDERSON, F. M., 1902, Cretaceous deposits of the Pacific Coast: Calif. Acad. Sci., proc. (3), vol. 2, pp. 1–154, pls. 1–12.

———, 1958, Upper Cretaceous of the Pacific Coast: Geol. Soc. Am. Memoir 71, 378 pp. 75 pls.

ARKELL, W. J., 1951, The English Bathonian ammonites, pt. I: Palaeontographical Soc., vol. 104, pp. 1–46, pls. 1–4, 9 text figs.

———, 1956, Jurassic geology of the world: Oliver and Boyd, Ltd., Edinburgh and London, 806 pp., 46 pls., 26 tables, 102 text figs.

———, KUMMEL, BERHNARD, and WRIGHT, C. W., 1957, Mesozoic Ammonoidea, *in* Moore, Editor, Treatise on Invertebrate Paleontology, (L) Mollusca 4: Univ. of Kans. Press, Lawrence, pp. L80–L465, figs. 124–558.

BAILY, W. H., 1855, Description of some fossils from South Africa; collected by Captain Garden, of the 45th Regiment: Quart. Jour. Geol. Soc. London, vol. 11, pp. 454–465, pls. 11–13.

BASSE, ÉLIANE, 1931, Monographie paléontologique du Crétacé de la Province de Maintirano, Madagascar: Service des Mines, Gouvernment Général de Madagascar et Dépendencies, Imprimerie Officielle, Tananarive, 86 pp., 13 pls.

———, 1937, Les Céphalopodes Crétacés de Massifs, Cotiers Syriens, *in* Contribution à l'Étude géologique de la Côte Libano-Syrienne: II Paléontologie (Paris), pp. 165–200, pls. 8–11.

———, 1939, Sur quelques Mollusques Crétacés des Corbières Méridionales: Soc. Géol. France, bull., ser. 5, vol. 9, pp. 35–58, pl. 3, 1 fig.

———, 1951, Quelques Mollusques de Crétacé de Colombie: Soc. Géol. France, bull., ser. 5, vol. 20, pp. 245–255, pl. 11, 1 text fig.

———, 1959, III.—Le Néocrétacé (Coniacion, Santonien, Campanien); *in* BASSE and SORNAY, Généralités sur les faunes d'ammonites du Crétacé Supérieur Francais; *in* Colloque sur le Crétacé Supérieur Francais: Comptes rendus du Congres des Societés Savantes de Paris et des Départments: Comité des Travaux historiques et scientifiques, section de sciences, sous-section de géologie, tenu a Dijon, Paris, Gauthier-Villars, pp. 20–23.

———, *et al.*, 1959, 11: Les Céphalopodes; *in* FABRE-TAXY, S., Le monde vivant et le milieu continental; *in* Colloque sur le Crétacé Supérieur Francais: Comptes rendus du Congres des Societés Savantes de Paris et des Départments: Comité des Travaux historiques et scientifiques, section des sciences, sous-section de géologies, tenu a Dijon, Paris, Gauthier-Villars, pp. 787–790.

BESAIRE, H., 1930, La rapports du Crétacé malgache avec le Crétacé de l'Áfrique du Sud: Soc. Géol. France, bull., ser. 4, vol. 30, pp. 613–614, pls. 44–47.

———, 1936, Recherches géologiques a Madagascar, Premiére Suite, Géologie du Nord-Ouest: Mémoires de l'Académie Malgache, Fascicle 21, 258 pp., 16 figs., table 1, 1 geologic map (text) and 24 pls., table 2 (atlas).

BÖSE, EMIL, 1913, Algunas faunas del Cretácico superior de Coahuila y regiones limitrofes: Instituto Geológico de México, num. 30, 54 pp., 8 pls.

———, 1919, On a new *Exogyra* from the Del Rio Clay and some observations on the Evolution of *Exogyra* in the Texas Cretaceous: Univ. of Texas bull. 1902, pp. 1–22, 1 fig., 5 pls.

———, 1928, Cretaceous ammonites from Texas and northern Mexico: Univ. of Texas bull. 2748, pp. 143–357, pls. 1–19.

———, and CAVINS, O. A., 1928, The Cretaceous and Tertiary of southern Texas and northern Mexico: Univ. of Texas bull. 2748, pp. 1–142.

BRAITHWAITE, PHILIP, 1958, Cretaceous stratigraphy of northern Rim Rock Country, Trans-Pecos Texas: Thesis, The Univ. of Texas, 95 pp., 2 pls. (inc. map), 9 figs., 2 tables.

BRAMLETTE, W. A., 1934, The fauna of the *Nostoceras* zone of the Taylor formation: Thesis, The Univ. of Texas, 103 pp., 5 pls.

BRUNDRETT, JESSE, 1955, Cretaceous stratigraphy of northeastern front of Davis Mountains, Jeff Davis County, Texas: Thesis, The Univ. of Texas, 121 pp., 4 pls. (inc. map), 13 figs., 2 tables.

BURCKHARDT, CARLOS, 1919, Faunas Jurasicas de Symon (Zacatecas) y Faunas Cretácicas de Zumpango del Rio (Guerrero): Inst. Geol. de México, bull. 33, text (1919), pp. 1–138 and atlas (1921), 30 pls.

———, 1930, Etude synthétique sur le Mésozoique mexicain, second partie: Société Paléontologique Suisse, Mémoires, vol. 50, pp. 125–280, figs. 34–64, tables 12–18.

BÜRGL, HANS, 1957, Biostratigrafia de la Sabana de Bogota y sus Alrededores: Service Geologico Nacional Colombia, Bol. Geol., vol. 5, no. 2, pp. 113–185, 19 pls., 1 map.

CALAHAN, L. W., 1939, Diagnostic fossils of the Ark-La-Tex area: Shreveport Geol. Soc., guidebook, 1939 ann. field trip, pp. 36–56, 10 pls.

CANNON, R. L., 1922, The fauna of the Escondido formation: Thesis, The Univ. of Texas, 59 pp., 22 pls.

CLARK, DAVID L., 1960, *Parapuzosia* in the North Texas Cretaceous: Jour. Paleontology, vol. 34, pp. 233–236, 2 text figs., pl. 34.

COBBAN, W. A., 1951a, Scaphitoid cephalopods of the Colorado group: U. S. Geol. Survey Professional Paper 239, 42 pp., 4 text figs., 21 pls.

———, 1951b, Colorado shale of central and northwestern Montana and equivalent rocks of

Black Hills: Am. Assoc. Petroleum Geol., vol. 35, pp. 2170–2198, 2 figs.

———, 1955, Some guide fossils from the Colorado shale and Telegraph Creek formation, northwestern Montana: Billings Geol. Soc., guidebook, 6th ann. field conf., pp. 198–207, ill.

———, 1958, Late Cretaceous fossil zones of the Powder River Basin, Wyoming and Montana: Wyoming Geol. Assoc., guidebook, 13th ann. field conf., pp. 114–119, 2 text figs.

———, and Reeside, J. B., Jr., 1952, Correlation of the Cretaceous formations of the Western Interior of the United States: Geol. Soc. Am., bull., vol. 63, pp. 1011–1044, 2 figs., 1 pl.

Collignon, M., 1932, Paléontologie de Madagascar, XVII.—Fossiles du Crétacé Supérieur de Menabe: Annales de Paléontologie, vol. 21, pp. 32–54, pls. 1–9, 21 figs.

———, 1948, Ammonites Néocrétacées du Menabe (Madagascar), I. Les Texanitidae (parts 1 and 2): Ann. Géol. du Service des Mines, Gouvernement Général de Madagascar et Dépendances, Imprimerie Nationale, Paris, fasc. 13 and 14, pp. 1–120, 32 pls., 11 figs., 2 charts.

———, 1955, Ammonites Néocrétacées du Menabe (Madagascar), II.—Les Pachydiscidae: Ann. Géol. du Service des Mines, fasc. 21, Haut Commissariat de Madagascar et Dépendances, Imprimerie Nationale, Paris, 98 pp., 21 figs., 28 pls.

———, 1959, Corrélations sommaires entre les dépôts du Crétacé Supérieur de Madagascar et ceux de l'Europe Occidentale, en particulier de la France; *in* Colloque sur le Crétacé Supérieur Francais: Comptes rendus du Congres des Societés Savantes de Paris et des Départments: Comite des Travaux historiques et scientifiques, section de science, sous-section de géologie, tenu a Dijon, Paris, Gauthier-Villars, pp. 41–52, 5 tables.

Conrad, T. A., 1857, Description of Cretaceous and Tertiary fossils, *in* Emory, W. H., Report on the United States and Mexican Boundary Survey . . . U. S. 34th Cong., 1st sess., Sen. Exec. Doc. 108, vol. 20 [U. S. serial no. 832] and House Exec. Doc. 135, vol. 14, vol. 1, pt. 2 [U. S. serial no. 861]: pp. 142–174, pls. 1–21.

Cope, E. D., 1880, On the zoological position of Texas: U. S. Nat. Mus., bull. 17, 51 pp.

Coquand, M. H., 1859, Synopsis des animeaux et des vegeteaux fossiles observes dan la formation cretacee du sud-ouest de la France: Soc. Geol. France, bull., 2 ser., vol. 16, pp. 945–1023.

Cragin, F. W., 1893, A contribution to the Invertebrate Paleontology of the Texas Cretaceous: Geol. Survey Tex., ann. rpt., 4, pt. 2, pp. i–vi + 141–294, pls. 26–46.

Crick, G. C., 1907, The Cephalopoda from the tributaries of Manuan Creek, Zululand, part 3, no. 2, of Cretaceous Fossils of Natal: Third and final report of the Geol. Surv. of Natal and Zululand, pp. 235–249, pl. 10.

Cushman, J. A., 1946, Upper Cretaceous Foraminifera of the Gulf Coastal region of the United States and adjacent areas: U. S. Geol. Survey Professional Paper 206, 241 pp. 66 pls.

Dalbiez, M. F., 1959, Corrélations et Résolutions (Introduction par M. J. Sigal); *in* Colloque sur le Crétacé Supérieur Francais: Comptes rendus du Congres des Societés Savantes de Paris et des Départments: Comité des Travaux historiques et scientifiques, section des sciences, sous-section de géologie, tenu a Dijon, Paris, Gauthier-Villars, pp. 857–867.

Dane, C. H., 1929, Upper Cretaceous formations of southwestern Arkansas: Ark. Geol. Survey bull. 1, 215 pp., 4 figs., 29 pls. (inc. map).

Deussen, Alexander, 1924, Geology of the Coastal Plain of Texas west of the Brazos River: U. S. Geol. Survey Professional Paper 126, 145 pp., 38 figs., 36 pls.

Duchin, Ralph, 1955, Pre-Cenozoic stratigraphy of Candelaria area, Presidio County, Texas: Thesis, The Univ. of Texas, 84 pp., 6 figs., 2 pls. (inc. geologic map), 1 correlation chart.

Dumble, E. T., 1890, A review of Texas Geology as developed by the work of the survey: Geol. Survey Tex., 1st ann. rpt. (for 1889), pp. xxix–lxxv, pl. 3.

———, 1915, Tertiary deposits of northeastern Mexico: Calif. Acad. Sci., pr., vol. 5, no. 6, pp. 163–193, pls. 16–19.

Durham, C. O., Jr., 1949, Stratigraphic relations of the Pilot Knob pyroclastics; *in* Cretaceous of the Austin Texas area: Shreveport Geol. Soc., guidebook, 17th ann. field trip, pp. 102–108, pls. 18–20.

———, 1955, Stratigraphic relations of Upper Cretaceous volcanics in Travis County, Texas; *in* Cretaceous of Austin, Texas area: Corpus Christi Geol. Soc. guidebook, ann. field trip, 1955, 6 unnumbered pp.

———, 1956, The Austin-Taylor relationship in Central Texas: *in* Resumenes de los Trabajos Presentados, XX Congreso Geologico Internacional, Mexico City, p. 330 (abs.).

Eifler, G. K., 1951, Geology of the Barilla Mountains, Texas: Geol. Soc. Am., bull., vol. 62, pp. 339–353, 1 fig., 2 pls. (reprinted as Bureau of Economic Geology Rpt. of Invest. no. 8).

Elias, M. K., 1931, The Geology of Wallace County, Kansas: State Geol. Survey of Kans. Bull. 18, 254 pp., 7 figs., 41 pls., 2 tables.

Fallot, J. Emmanuel, 1885, Étude géologique sur les étages moyens et supérieurs du terrain Crétacé dans le Sud-est de la France: thésis prèsentées a la Faculté des Sciences de Paris, G. Masson, Paris, 268 pp., 8 pls.

Feray, Dan E., and Plummer, Helen Jeanne, 1949, Road cuts in new highway 20, Walnut Hill area, Travis County, Texas, *in* Cretaceous of Austin Texas area: Shreveport Geol. Soc., guidebook, 17th ann. field conf., pp. 61–62.

Fiege, Kurt, 1951, The zone, base of biostratigraphy: Am. Assoc. Petroleum Geol., vol. 35, pp. 2582–2596

Frech, Fritz, 1915, Uber Scaphites. I. Die Bedeutung von *Scaphites* fur die Gliederung der Oberkreide; II. Uber die Rückbildung der skulptur bei der jüngsten Scaphitenart: Centralblatt für Mineralogie, Geologie und Paläontologie, Jahrgang 1915, pp. 553–568, 14 figs. (pt. I) and pp. 617–621, 2 figs. (pt. II).

Fritsch, Anton, and Schloenbach, Urban, 1872, Cephalopoden der Böhmischen Kreideformation: Prague, 51 pp., 16 pls.

Frizzell, Don L., 1954, Handbook of Cretaceous Foraminifera of Texas: Bureau of Economic

Geology, The Univ. of Texas, Rpt. of Invest. no. 22, 232 pp., 21 pls., 2 figs., 4 tables.

GARDNER, JULIA, 1916, Systematic Paleontology, Upper Cretaceous; *in* CLARK, W. B., *et al.*, Upper Cretaceous: Maryland Geol. Survey, pp. 371–733, pls. 12–45.

GERHARDT, K., 1897, Beitrag zur kenntniss der Kreideformation in Venezuela und Peru: Neues Jahrbuch fur Mineralogie, Beilage Band, vol. 11, pp. 65–208, pls. 1–5, text figs. 1–20.

GIGNOUX, MAURICE, 1955, Stratigraphic geology; English ed., translated from the 4th French edition by Gwendolyn C. Woodford; Freeman and Co., San Francisco, 682 pp., 155 text figs.

GRABAU, A. W., and SHIMER, H. W., 1909–1910, North American Index Fossils: New York, A. G. Seiler & Co., vol. 1, 853 pp., figs. 1–1209 (1909) and vol. 2, v + 909 pp., figs., 1211–1937 (1910).

GROOT, J. J., ORGANIST, D. M., and RICHARDS, H. G., 1954, Marine Upper Cretaceous formations of the Chesapeake and Delaware canal: Delaware Geol. Survey, bull. 3, 62 pp., 7 pls., several tables

GROSSOUVRE, A. de, 1894, Recherches sur la Craie Supérieure. II. Paléontologie les Ammonites de la Craie Supérieure: Mem. la Carte Géol. Détaillée de France. Paris, Imprimerie Nationale. 264 pp., 39 pls.

———, 1901, Recherches sur la Craie Supérieure. Prémiére parte, Stratigraphie générale: Mémoires, Carte géol. détaillée France, 559 pp., 21 tables, 27 figs

———, 1908, Description des ammonitides du Crétacé Supérieur du Limbourg Belge et Hollandais et du Hainaut: Mém. Musée d'Hist. Nat. Belgique, vol. 4, pp. 1–39, pls. 1–11.

HAAS, OTTO, 1942, Some Upper Cretaceous ammonite from Angola: Am. Mus. Novitates, no. 1182, 24 pp., 12 text figs.

———, 1946, Intraspecific variation in, and ontogeny of, *Prionotropis woollgari* and *Prionocyclus wyomingensis*: Am. Mus. Nat. Hist., bull., vol. 86, art. 4, 224 pp., 108 figs., 24 pls.

———, 1949, Acanthoceratid Ammonoidea from near Greybull, Wyoming: Am. Mus. Nat. Hist., bull., vol. 93, art. 1, 39 pp., 15 pls., 17 text figs.

———, 1958, Recent literature on Mesozoic ammonites; Jour. Paleontology; vol. 32, pp. 624–635.

HALL, JAMES, and MEEK, F. B., 1856, Description of new species of fossils from the Cretaceous formations of Nebraska, with observations upon *Baculites ovatus* and *B. compressus*, and the progressive development of the septa in *Baculites, Ammonites, Scaphites*: Am. Ac. Arts and Sci., Mem., n.s., vol. 5, pp. 379–411, pls. 1–8.

HARTWIG, A. E., JR., 1952, Geology of the Mozo quadrangle, Williamson County, Texas: Thesis, The Univ. of Texas, 66 pp., 3 pls. (incl. map and correlation chart), 15 text figs.

HAUG, ÉMILE, 1908–1911, Traité de Géologie, 2nd vol., Les Periodes Géologique: Librairie Arman Colin, Paris, pt. 1, pp. 539–1396, figs. 196–404, pls. 72–119.

HAZZARD, R. T., *et al.*, 1956, Four Provinces Field Trip: guide book, San Angelo Geol. Society, pt. III, pp. 43–76, ill.

HEDBERG, H. D., 1958, Stratigraphic classification and terminology: Am. Assoc. Petroleum Geol., bull., vol 42, pp. 1881–1896, 1 text fig.

HEINZ, R., 1928, Das Inoceramenprofil der oberen Kreide Luneburgs: Jber. niederis. geol. Ver., vol 21, 25 pp., Hamburg.

HILL, ROBERT T., 1887, The present condition of knowledge of the geology of Texas: U. S. Geol. Survey bull. 45, 95 pp., 6 unnumbered tables and figures.

———, 1889a, An approximate map of the topography of the Texas region: *in* Univ. Tex. [unnumbered at time of issue; subsequently assigned to bull. no. 53 by the Univ of Tex.]

———, 1889b, A portion of the geologic story of the Colorado River of Texas: Am. Geol., vol. 3, pp. 287–299.

———, 1889c, A preliminary annotated check list of the Cretaceous invertebrate fossils of Texas, accompanied by a short description of the lithology and stratigraphy of the system: Texas Geol. Surv., bull. 4, xxxi + 57 pp.

———, 1890a, Classification and origin of the chief geographic features of the Texas region: Am. Geol., vol. 5, pp. 9–29, 68–80, map.

———, 1890b, Pilot Knob; a marine Cretaceous volcano: Am Geol., vol 6, pp. 286–292, ill.

———, 1893, The Cretaceous Formations of Mexico and their relations to North American Geographic Development: Am. Jour. Sci., vol. 145 (third ser., vol. 45), pp. 307–324, four unnumbered figures and 1 table.

———, 1894, Geology of parts of Texas, Indian Territory, and Arkansas adjacent to Red River: Geol Soc. Am., bull., vol. 5, pp. 297–338, pls. 12, 13

———, 1901, Geography and geology of the Black and Grand Prairies, Texas: U. S. Geol. Survey ann. rpt. 21, pt. 7, 666 pp., 80 figs., 71 pls.

———, and VAUGHAN, T. W., 1898, Geology of the Edwards Plateau and Rio Grande Plain adjacent to Austin and San Antonio, Texas, with reference to the occurrence of underground waters: U. S. Geol. Survey ann. rpt., 18, pt. 2, pp. 193–321, pls. 21–54, figs. 53–76.

———, 1902, Description of the Austin quadrangle: U. S. Geol. Survey Geologic Atlas, folio 76, 8 pp., 52 figs., 3 maps., 1 section.

HOEPEN, E. C. N., VAN, 1921, Cretaceous Cephalopoda from Pondoland· Annals Transval Mus., vol. 8, pt. 1, pp. 1–48, pls. 1–11.

HOURCQ, VICTOR, 1949, Paléontologie de Madagascar, XXVIII.—Sur quelques ammonites du Senonian: Ann. de Paléo., vol. 35, pp. 87–118, 24 figs., pls. 11–13.

HYATT, ALPHEUS, 1903, Pseudoceratites of the Cretaceous: U. S. Geol. Survey Monograph 44, 351 pp., 47 pls.

IMLAY, RALPH W., 1944, Cretaceous formations of Central America and Mexico; Am. Assoc. Petroleum Geol., bull., vol. 28, pp. 1077–1195, figs. 1–16, correlation chart.

JELETZKY, J. A., 1951, Die Stratigraphie und Belemnitenfauna des Obercampan und Maastricht Westfalens, Nordwestdeutschlands und Dänemarks, sowie einige allgemeine Gliederungs-Probleme der jüngeren borealen Oberkreide Eurasiens: Geolgisches Jahrbuch, Geologischen Landesanstalten der Bundesrepublik

Deutschland, Beiheft 1, 142 pp., 7 pls., 3 tables.

———, 1955a, Evolution of Santonian and Campanian *Belemnitella* and Paleontological systematics; exemplified by *Belemnitella praecursor* Stolley: Jour. Paleontology, vol. 29, pp. 478–509, pls. 56–58.

———, 1955b, *Belemnitella praecursor*, probably from the Niobrara of Kansas, and some stratigraphic implications: Jour. Paleontology, vol. 29, pp. 876–885, 1 text fig.

———, 1958, Die jüngere Oberkreide (Oberconiac bis Maastricht) Südwestrusslands und ihr Vergleich mit der Norewest- und Westeuropas: Beiheft zum Geologischen Jahrbuch, Heft 33, 157 pp., 11 figs., correlation chart.

JIMBO, K., 1894, Beitrage zur kenntniss der Kreideformation von Hokkaido (Japan): Palaeont. Abh., n. f., Bd. 2 (6), Heft 3, pp. 1–46, pls. 1–39.

JOHNSON, D. W., 1904, The geology of the Cerillos Hills, New Mexico: Cont. from Geol. Dept., Columbia Univ., vol. 10, no. 90, 221 pp., pls. A–U and 1–14, plus unnumbered figs.

JOHNSON, J. HARLAN, 1944, Algal reefs in Cretaceous Austin chalk of Terlingua district, Brewster County, Texas: Am. Assoc. Petroleum Geol., vol. 28, pp. 123–126, 1 fig.

KOSSMAT, FRANZ, 1895–1898, Untersuchungen über die Südindische Kreideformation: Beitrage zur Paläontologie und Geologie Ostereich-Ungarns und des Orients, vol. 9, pp. 97–203, pls. 15–25 (1895), vol. 11, pp. 1–46 and 91–152, pls. 1–8 and 14–19 (1898).

LASSWITZ, RUDOLPH, 1904, Die Kreide-ammoniten von Texas: Geol. Abhandlungen, vol. 10 (n. s.), Band 6, Heft 4, pp. 1–40, 8 pls., 8 text figs.

LONSDALE, J. T., MAXWELL, ROSS, WILSON, JOHN A., and HAZZARD, R. T., 1955, Big Bend Field Trip: West Texas Geol. Soc. guidebook, pp. 1–142, 25 figs., 9 tables.

LOZO, F. E., and STRICKLIN, F. L., JR., 1956, Stratigraphic notes on the outcrop basal Cretaceous, Central Texas: Gulf Coast Assoc. of Geol. Societies, trs., vol. 6, pp. 67–78, 8 figs.

MARCOU, JULES, 1862, Notes on the Cretaceous and Carboniferous of Texas: Boston Soc. Nat. Hist., proc., vol. 8, pp. 86–97.

MARKS, EDWARD, 1950, Biostratigraphy of Jonah Quadrangle, Williamson County, Texas: Thesis, The Univ. of Texas, 140 pp, 38 pls., 2 maps, 1 correlation chart.

———, 1952, Occurrence of Santonian crinoid in western Gulf Region: Am. Jour. Sci., vol. 250, pp. 226–227

MATSUMOTO, TATSURO, 1955, Evolution of Peroniceratidae: Trans. and Proc. Paleontology Soc. of Japan, n. s, vol. 18, pp. 37–44.

———, 1959a, A review of F. M. Anderson's Upper Cretaceous Ammonites of the West Coast of North America: Jour. of the Geol. Soc. of Japan, vol. 64, no. 759, pp. 650–653.

———, 1959b, Zonation of the Upper Cretaceous in Japan: Memoirs of the Faculty of Science, Kyushu Univ., ser. D, Geology, vol. 9, no. 2, pp. 55–97, pls. 6–11.

———, 1959c, Upper Cretaceous Ammonites of California, part II: Memoirs of the Faculty of Science, Kyushu Univ., ser. D, Geology, special vol. I, 172 pp., 80 text figs., 41 pls.

———, 1960, Upper Cretaceous Ammonites of California, part III, with notes on stratigraphy of the Redding area and the Santa Ana Mountains by Matsumoto, Tatsuro, and Popenoe, W. P.: Memoirs of the Faculty of Science, Kyushu Univ., ser. D, Geology, special vol. 2, 204 pp., 3 pls., 20 figs.

MAURY, C. J., 1930, O Cretace da Parahyba do Norte: Serv. Geol. e Min. do Brasil. Mon. VIII, 305 pp., 35 pls., map.

MCNULTY, C. L., 1954, Fish bed conglomerate and sub-Clarksville sand, Grayson and Fannin Counties, Texas: Am. Assoc. Petroleum Geol., bull., vol. 38, pp. 335–337.

———, 1955, Foraminifera of the Austin group in northeast Texas: Jour. Sedimentary Petrology, vol. 25, pp. 145–146 (abs.)

MILLER, A. K., and YOUNGQUIST, WALTER, 1946, A giant ammonite from the Cretaceous of Montana: Jour. Paleontology, vol. 20, pp. 479–484, pls. 73–75.

MILLER, WAYNE, 1957, Pre-Cenozoic stratigraphy of Porvenir area, Presidio County, Trans-Pecos Texas: Thesis, The Univ. of Texas, vii + 97 pp., 2 tables, 4 maps, 1 correlation chart, 2 diagrams, 8 text figs.

MOON, C. GARDLEY, 1953, Geology of the Agua Fria Quadrangle, Brewster County, Texas: Geol. Soc. Am., bull., vol. 64, pp. 151–195, 4 figs., 4 pls., 2 tables (also issued as Bureau of Economic Geology, The Univ. of Texas, Rpt. of Invest. no. 15).

MORTON, S. G., 1829, Description of the fossil shells which characterize the Atlantic Secondary formation of New Jersey and Delaware, including four new species: Jour. Acad. Nat. Sci. Phila., 1st ser., vol. 6, pt. 1, pp. 72–100, pls. 3–6

———, 1830, Synopsis of the organic remains of the ferruginous sand of the United States: Am. Jour. Sci., vol. 18, pp. 243–250, pls. 1 and 2.

———, 1834, Synopsis of the organic remains of the Cretaceous group of the United States. Illustrated by nineteen plates, to which is added an appendix containing a tabular view of the Tertiary fossils hitherto discovered in America: Philadelphia, 88 pp., 19 pls., app. 1–8

MUIR, JOHN M., 1936, Geology of the Tampico Region, Mexico: Am. Assoc. Petroleum Geol., speci. pub., 280 pp., 40 figs., 15 pls., 9 tables.

MULLER, S. W., and SCHENCK, H. G., 1943, Standard of Cretaceous System: Am. Assoc. Petroleum Geol., vol. 27, pp. 262–278, 7 text figs.

NEAVERSON, E., 1955, Stratigraphical Palaeontology: Oxford, Clarendon Press, 806 pp., 18 pls., 87 text figs.

NEWELL, NORMAN D., 1949, Types and hypodigms: Am. Jour. Sci., vol. 247, pp. 134–142.

NOWAK, JAN., 1911, Untersuchungen über die Cephalopoden der oberen Kreide in Polen, II. Teil: Die Scaphiten; Anzeiger der wissenschaften in Krakau, Mathematisch-Naturwissenschaftliche Klasse, Reihe B: Biologische wissenschaften, Année 1911, pp. 547–589, pls. 32–33, 19 figs.

———, 1913, Untersuchungen über die Cephalopoden der oberen Kreide in Polen. III Teil; Anzeiger der wissenschaften in Krakau, Mathematisch-Naturwissenschaftliche Klasse, Reihe

B: Biologische wissenschaften, Année 1913, pp. 335–415, pls. 40–45, 1 fig.

———, 1916, Zur Bedeutung von *Scaphites* für die Gliederung der Oberkreide: Verhandlungen der K. K. geologischen Reichsanstalt, no. 3, pp. 55–67, one correlation chart.

Orbigny, Alcide de, 1840, Paléontologie Francaise, Terrains Crétacés: Paris, vol. 1, text, 662 pp., atlas 148 pls.

Patton, J. L., 1932, The paleontology of the Austin chalk in Travis and Williamson Counties: Thesis, The Univ. of Texas, 27 pp., 14 pls., 1 table.

Peron, A., 1897, Les Ammonites du Crétacé Supérieur de l'Algerie: Soc. Géol. de France, Mémoir 17 (part 2), pp. 25–80, pls. 1–12.

Pervinquiere, L., 1907, Études de Paléontologie Tunisiene, I. Céphalopodes des Terrains Secondaires: Paris, F. R. de Ruderol, v + 438 pp., 27 pls.

———, 1910, Sur Quelques Ammonites Crétacé Álgerién: Mém. de la Soc. Géologique de France, Paléontologie, vol. 17, Fascicles 2–3, Mém. 42, 86 pp., pls. 10–16, 38 text figs.

Plummer, Helen Jean, 1949, Foraminifera in some Cretaceous outcrops in Travis County, Texas; in Cretaceous of Austin, Texas area: Shreveport Geol. Soc., guidebook, 17th ann. field trip, pp. 98–101 + 1.

Redtenbacher, Anton, 1873, Die Cephalopoden fauna der Gosauschichten in den nordöstlichen Alpen: aus der Königl. und Hof- und Statsdruckerei; p. 91–140, pls. 22–30.

Reeside, J. B., Jr., 1927a, The Cephalopods of the Eagle sandstone and related formations in the Western Interior of the United States: U. S. Geol. Survey Professional Paper 151, 87 pp., 1 fig., 45 pls.

———, 1927b, The Scaphites, an Upper Cretaceous ammonite group: U. S. Geol. Survey Professional Paper 150-B, pp. 1–40, pls. 9–11.

———, 1927c, Cephalopods from the lower part of the Cody shale of Oregon Basin, Wyo.: U. S. Geol. Survey Professional Paper 150, pp. 1–19, pls. 1–8.

———, 1932, The Upper Cretaceous ammonite genus Barroisiceras in the United States: U. S. Geol. Survey Professional Paper 170-B, pp. 9–29, pls. 3–10.

Reiss, Z., 1952, On the Upper Cretaceous and lower Tertiary microfaunas of Israel: Geol. Inst., Govt. of Israel and the Hebrew Univ., Pub. 2 (Bull. Res. Council of Israel, vol. II, no. 1), pp. 37–50

———, 1955, Micropaleontology and the Cretaceous-Tertiary boundary in Israel: Bull. Res. Council of Israel, Sec. B., Biol. and Geol., pub. no. 8, pp. 105–120, 1 table.

Renz, H. H., 1936, Neue Cephalopoden aus der oberen Kreide vom Rio Grande del Norte (Mexico und Texas), mit einer Einführung von Walther Staub: Abh. Schweizer. Paleont. Gesell., vol. 57, pp. 1–16, 1 fig., pls. 1–4.

Reyment, Richard, 1957, Über einige wirbellose Fossilien aus Nigerien und Kamerun, Westafrika: Palaeontographica, Band 109, Abt. A, pp. 41–70, text figs. 1–7, pls. 7–10.

———, 1958a, Übersichtliche Ergänzung von F. Solgers "Die Fossilien der MungoKreide in Kamerun und ihre Geologishe Bedeutung (1904)": Acta Universitatis Stockholmiensis, Stockholm Contributions in Geology, vol. 2:4, pp. 51–72, 2 text figs., 7 pls.

———, 1958b, Uber einige Ammoniten aus dem Coniac Kolumbiens und Venezuelas, Sudamerika: Acta Universitatis Stockholmiensis, Stockholm Contributions in Geology, vol. 2:1, pp. 1–25, pls 1–4.

———, 1958c, Neubeschreibung der Redtenbacher'schen Ammonitenoriginale aus den Gosauschichten: Acta Universitatis Stockholmiensis, Stockholm Contributions in Geology, vol. 2:3, pp. 31–49, text figs. 1–6, pls. 1–12.

Richards, Horace G., 1958, Cretaceous Pelecypoda of New Jersey, *in* Richards, H. G., *et al.*, The Cretaceous fossils of New Jersey, pt. I: New Jersey Bur. of Geol. and Topog., bull. 61, Paleontology series, pp 59–266, pls. 10–43.

Riedel, L., 1932, Die Oberkreide von Mungofluss in Kamerun und ihre Fauna: Beiträge zur geologischen Erforschung der Deutschen Schutzgebiete, Heft 16, 150 pp., 47 figs., 38 pls., Berlin.

Romberg, G., and Barnes, V. E., 1954, A geological and geophysical study of Pilot Knob (South), Travis County, Texas: Geophysics, vol. 19, pp. 438–454.

Robson, G. C., 1929, A Monograph of the Recent Cephalopoda, pt. I, Octopodinae: British Mus. of Nat. Hist., xi + 235 pp., 88 text figs., 7 pls.

———, 1932, A Monograph of the Recent Cephalopoda, pt. II, the Octopoda: British Mus. of Nat. Hist., 359 pp., 79 text figs., 6 pls.

Roman, Frédéric, 1938, Les Ammonites Jurassiques et Crétacées. Essae de Genera: Paris, Masson et Cie, 554 pp., 493 text figs., 53 pls.

Römer, Ferdinand, 1852, Die Kreidebildungen von Texas, und ihre organischen Einschlüsse: Bonn, Adolph Marcus, 100 pp., 10 pls.

———, 1888, Ueber eine durch die Häufigkeit Hippuriten-artiger Chamiden ausgezeichnete Fauna der Oberturonen Kreide von Texas: Palaeo. Abh., vierter Band, Heft 4, pp. 1–18, 3 pls.

Say, Thomas, 1820, Observations on some species of Zoophytes, shells, & c. principally fossils: Am. Jour. Sci., vol. 2, pp. 34–46.

Schlüter, Clemens, 1867, Beitrag zur Kenntniss der Ammoneen Nordeutschlands: [*not seen*]

———, 1872, Cephalopoden der Oberen Deutschen Kreide, pt. 1: Palaeontographica, vol. 21, pp. xii + 120, pls. 1–35.

———, 1876, Cephalopoden der oberen Deutschen Kreide, pt. 2: Paleontographica, vol. 24, pp. 121–263, pls. 36–55.

———, 1887, Einige Inoceramen und Cephalopoden der Texanischen Kreide: Niederrhein. Ges. Bonn, Szb., vol. 44, pp. 42–45.

Schmid, Friedrich, 1959, La Définition des limites Santonien-Campanien et Campanien Inférieur-Supérieur en France et dans le Nord-ouest de l'Allemagne; *in* Colloque sur le Crétacé Supérieur Francais; Comptes rendus du Congres des Societés Savantes de Paris et des Départments: Comité des Travaux historiques et scientifiques, section des sciences, sous-section de géologie, tenu a Dijon, Paris, Gauthier-Villars, pp. 535–546.

SCHUCHERT, CHARLES, 1943, Stratigraphy of the eastern and central United States: John Wiley and Sons, New York, 1013 pp., 76 charts, 123 figs., 3 pls.

SCOTT, GAYLE, 1927, Études stratigraphiques et paléontologique sur les terrains Crétacés du Texas: Travaux du Laboratoire de Géologie de la Faculté de Sciences de l'Université de Grenoble, vol. 14, 2nd fascicle, pp. 77–295, 3 pls.

———, 1933, The Cretaceous of Texas; *in* Oklahoma and Texas, prepared under the direction of W. E. Wrather: International Geol. Congress, XVI session, guidebook 6, excursion A-6, pp. 46–66, pls. 7–8, figs. 15–16.

———, and MOORE, MARCUS H., 1928, Ammonites of enormous size from the Texas Cretaceous: Jour. Paleontology, vol. 2, pp. 273–278, 2 pls.

SELLARDS, E. H., 1931, Historical sketch of Balcones fault (from notes furnished by R. T. Hill): South Texas Geol. Soc., Field Trips, March, 1931, page 6.

SHARPE, DANIEL, 1857, Fossil Remains of Mollusca found in the chalk of England, Pt. III: Cephalopoda; Palaeontographical Society, vol. 9, pp. 37–68, pls. 17–27.

SHIMER, H. W., and SHROCK, R. R., 1944, Index Fossils of North America: John Wiley and Sons, New York, 837 pp., 303 pls.

SHUMARD, B. F., 1860, Observations upon the Cretaceous strata of Texas: St. Louis Academy of Sci., trans., vol. 1, pp. 582–590.

SIMPSON, G. G., 1940, Types in modern Taxonomy: Am. Jour. Sci., vol. 238, pp. 413–431.

SORNAY, JACQUES, 1957a, Ammonites du Coniacien du massif de la Haute Medjerda (Constantine, Algeria): Soc. Géol. de France, bull., 6th ser., vol. 7, pp. 187–196, pl. 16, 2 text figs.

———, ed., 1957b, Crétacé: Lexique Stratigraphique International, vol. 1, Europe, Fascicule 4a, France, Belgique, Pays-Bas, Luxembourg, Fascicule 4aVI: Congrés Géologique International, Commission de Stratigraphie, 403 pp, 5 maps.

———, 1959, IV.—Le Maestrichtien; *in* BASSE & SORNAY, Généralités sur les faunes d'Ammonites du Crétacé Supérieur Francais; *in* Colloque sur le Crétacé Supérieur Francais: Comptes rendus du Congres des Societés Savantes de Paris et des Départments: Comité des Travaux historiques et scientifiques, section des sciences, sous-section géologie, tenu a Dijon, Paris, Gauthier-Villars, pp. 23–26.

SPATH, L. F., 1921a, On Cretaceous Cephalopoda from Zululand: Annals South African Mus., vol. 12, pt. 7, pp. 217–321, pls. 19–26.

———, 1921b, On Upper Cretaceous Ammonoidea from Pondoland: Annals Durban Mus., vol. 3, pt. 2, pp. 39–56, pls. 6–7.

———, 1922, On the Senonian ammonite fauna of Pondoland: Trans. Royal Soc. South Africa, vol. 10, pt. 3, pp. 113–147, pls. 5–9

———, 1923, A Monograph of the Ammonoidea of the Gault, pt. 1: Palaeontographical Soc., vol. 75, pp. 1–72, pls. 1–3. text figs. 1–14.

———, 1925, On Upper Albian Ammonoidea from Portuguese East Africa, with an appendix on Upper Cretaceous ammonites from Maputoland: Annals Transval Mus., vol. 11, pp. 179–200, pls. 28–37.

———, 1926, On new ammonites from the English chalk: Geol. Mag., vol. 63, pp. 71–83, 1 table.

———, 1931, A Monograph of the Ammonoidea of the Gault, pt. 8: Palaeontographical Soc., vol. 83, pp. 313–378, text figs. 103–124, pls. 31–36.

———, 1932, A Monograph of the Ammonoidea of the Gault, pt. 9; Palaeontographical Soc., vol. 84, pp. 379–410, text figs. 125–140, pls. 37–42.

———, 1933, Revision of the Jurassic cephalopod fauna of Kachh (Cutch), pt. 6: The Geol. Survey of India, Palaeontologia Indica, Memoirs, n. s., vol. 9, Mem. 2, pp. iii–vii + 659–945, pls. 125–130.

———, 1953, The Upper Cretaceous cephalopod fauna of Graham Land: Falkland Islands Dependencies Survey, Scientific Reports no. 3, London, Her Majesty's Stationery Office, 60 pp., 13 pls., 1 map.

STANTON, T. W., 1893, The Colorado Formation and its Invertebrate Fauna: U. S Geol. Survey bull. 106, 288 pp., 45 pls.

STEPHENSON, L. W., 1914, Cretaceous deposits of the eastern Gulf region and species of Exogyra from the eastern Gulf region and the Carolinas: U. S. Geol. Survey Professional Paper 81, 77 pp., 2 figs., 21 pls. 9 tables.

———, 1918, A contribution to the geology of northeastern Texas and southern Oklahoma: U. S. Geol. Survey Professional Paper 120, pp. 129–163, pls. 18–30, 1 unnumbered table.

———, 1923, Invertebrate Fossils of the Upper Cretaceous formations with a supplemental chapter on the Decapod Crustaceans of the Upper Cretaceous formations by Mary J. Rathbun; *in* The Cretaceous formations of North Carolina; North Carolina Geol. and Econ. Survey, publications, vol. 5, part 1, 604 pp, 6 figs, 102 pls.

———, 1927, Notes on the stratigraphy of the Upper Cretaceous formations of Texas and Arkansas: Am. Assoc. Petroleum Geol., vol. 11, pp. 1–17, 1 pl.

———, 1928, Correlation of the Upper Cretaceous or Gulf Series of the Gulf Coastal Plain: Am. Jour. Sci., vol. 216, (5th ser. vol. 16), pp. 485–496, 1 fig.

———, 1929a, Age of Brownstown marl of Arkansas: Am. Assoc. Petroleum Geol., bull., vol. 13, pp. 1073–1074.

———, 1929b, Unconformities in Upper Cretaceous Series of Texas: Am. Assoc. Petroleum Geol., bull., vol. 13, pp. 1323–1334, 5 figs.

———, 1933, The zone of *Exogyra cancellata* traced 2500 miles: Am. Assoc. Petroleum Geol., bull., vol. 17, pp. 1351–1361, 1 fig.

———, 1936, New Upper Cretaceous Ostreidae from the Gulf region: U. S. Geol. Survey Professional Paper 186-A, pp. 1–12, pls. 1–3.

———, 1937, Stratigraphic relations of the Austin, Taylor, and equivalent formations in Texas; U. S. Geol. Survey Professional Paper 186-G, pp. 133–146, fig. 7, pl. 44.

———, 1939, Cretaceous System, *in* STEPHENSON, L. W., COOKE, C. WYTHE, and GARDNER, JULIA, The Atlantic and Gulf Coastal Plain, *in* Ruedemann and Balk, editors, The Geology of North America: Geologie der Erde, Gebrüder Borntraeger, Berlin, pp. 532–549, pls. 2–4.

———, 1941, The larger invertebrate fossils of the Navarro group (exclusive of corals and crustaceans and exclusive of the fauna of the Escondido formation): Univ. Texas Pub. 4101, 641 pp., 95 pls., 13 figs., 6 tables.

———, 1956, Fossils from the Eutaw formation, Chattahoochie River region, Alabama-Georgia: U. S. Geol. Survey Professional Paper 274-J, pp. 227–250, pls 38–45, fig 30.

———, and MONROE, W. H, 1940, The Upper Cretaceous deposits: Mississippi Geol. Surv. bull. 40, pp. 296, 48 text figs., 15 pls.

———, and REESIDE, J. B. JR, 1938, Comparison of Upper Cretaceous deposits of Gulf region and Western Interior region: Am. Assoc. Petroleum Geol., Bull., vol. 22, pp. 1629–1638, 3 text figs.

———, *et al.*, 1942, Correlation of the outcropping Cretaceous formations of the Atlantic and Gulf Coastal Plain and Trans-Pecos Texas: Geol. Soc. Am., bull., vol. 53, pp. 435–448, 1 pl.

SYLVESTER-BRADLEY, P. C., 1956, The New Paleontology: Systematics Assoc. Publication no. 2, The Species Concept in Paleontology; pp. 1–8, 1 text fig.

TAFF, J. A., 1892, Reports on the Cretaceous area north of the Colorado River; I, The Bosque Division; II, The Lampasas-Williamson section: Tex. Geol. Surv. ann. rpt., vol. 3, pp. 267–379, ill.

———, 1902, Chalk of southwestern Arkansas: U. S Geol Survey, 22nd ann. rpt., pp. 689–763, figs. 57–69, pls. 47–53.

TATUM, J. L., 1931, General geology of northeast Mexico: Am. Assoc. Petroleum Geol., bull., vol. 15, pp. 867–893, 1 fig., 1 table.

TRASK, J B, 1856, Description of a new species of ammonite and baculite from the Tertiary rocks of Chico Creek: Calif. Acad. Sci. proc., vol. 1, pp. 85–86 (2nd ed., 1873, pp. 92–93).

TROOST, GERARD, 1840, Organic Remains discovered in the state of Tennessee, *in*, 5th Geol. rpt. of the state of Tennessee, pp. 45–75.

TRUEMAN, A. E., and WIER, J., 1946, A Monograph of British Carboniferous non-marine Lamellibranchia, pt. 1: Palaeontographical Society, vol. 99, i–xxxiii + 1–18 pp., pls. 1–4, text figs. i–v + 1–4.

UDDEN, J. A, 1907, A sketch of the Geology of the Chisos Country, Brewster Co., Texas: Univ. of Texas bull. 93 (sci. ser. no. 11), 101 pp

VENZO, S., 1936, Cefalopodi del Cretaceo medio-superiore dello Zululand: Palaeontographica Italica, vol. 36, pp. 59–133, pls. 5–12.

WADE, BRUCE, 1926, The fauna of the Ripley formation on Coon Creek, Tennessee: U. S. Geol. Survey Professional Paper 137, 272 pp., 2 figs., 72 pls

WEISS, E J., and CLABAUGH, S. E., 1955, Mineralogy of the "Serpentine" at Pilot Knob near Austin, Texas: Tex. Jour. Sci., vol. 7, pp. 136–148, 7 text figs., 2 tables.

WELLER, STUART, 1907, A report on the Cretaceous Paleontology of New Jersey: Geol. Survey New Jersey, paleontology series, vol. 4, pp. ix + 871 (text), 111 pls. (atlas).

WHITE, C. A, 1875, Report upon the invertebrate fossils collected in portions of Nevada, Utah, Colorado, New Mexico, and Arizona, by parties of the expeditions of 1871, 1872, 1873, 1874; Rept., Geog. and Geol. Expl. and Survey west of 100th Merid., vol. 4, pt. 1, paleontology, pp. 1–219, pls 1–21.

———, 1884, A review of fossil Ostreidae of North America, and a comparison of the fossil with the living forms, with appendices by Prof. Angelo Heilprin and Mr. John A. Ryder: U. S. Geol. Survey, 4th ann. rept., pp. 273–430, pls. 36–82.

WHITEAVES, J. F., 1879, On the fossils of the Cretaceous rocks of Vancouver and adjacent islands in the strait of Georgia: Geol. Survey Canada, Mesozoic Fossils, vol. 1, pt. 2, pp. 93–190, pls. 11–20.

WHITFIELD, R. P., 1892, Gastropoda and Cephalopoda of the Raritan clays and greensand marls of New Jersey: U. S. Geol. Survey, Monograph 18, 402 pp., 50 pls.

WOLANSKY, DORA, 1932, Die Cephalopoden und Lamellibranchiaten der Ober-Kreide Pommerns, mit einem abriss der Stratigraphie des Sudbaltikums vom Wealden bis zum Senon: Abh. Geol.-palaeo. Inst. der Univ. Greifswald, 72 pp, 8 text figs, 5 pls.

WOODS, HENRY, 1906, The Cretaceous fauna of Pondoland: Annals South African Mus., vol. 4, pt. 7, pp 275–350, pls. 33–42.

———, 1912, A Monograph of the Cretaceous Lamellibranchia of England, vol II, pt. 8: Palaeontographical Soc., vol. 65, pp. 285–340, pls. 51–54, text figs. 41–97.

———, 1913, A Monograph of the Cretaceous Lamellibranchia of England, vol. II, pt. IX: Palaeontographical Soc., vol. 66, pp. 341–473, pls. 55–62, text figs. 98–252, 2 tables.

WRIGHT, C. W., 1955, Notes on Cretaceous ammonites.—II. The Phylogeny of the Desmocerataceae and the Hoplitaceae: Annals and Magazine of Natural History, ser. 12, vol. 8, pp. 561–575.

———, and WRIGHT, E. V., 1951, A Survey of the fossil cephalopoda of the Chalk of Great Britain: Palaeontographical Soc., vol. 104, pp. 1–40.

YABE, H., and SHIMIZU, S., 1923, A note on the genus *Mortoniceras*: Japanese Jour. of Geol. and Geog, vol. 2, no. 2, pp. 27–30.

———, 1926, Cretaceous ammonites belonging to Prionotropidae I: Japanese Jour. Geol. and Geog., vol. 5, no. 1–2, p. (2) (abs.).

YATES, ROBERT G., and THOMPSON, GEORGE A., 1959, Geology and Quicksilver deposits of the Terlingua District: U. S. Geol. Survey Professional Paper 312, 114 pp., 22 pls., 25 figs., 15 tables.

YOUNG, KEITH, 1957, Upper Albian (Cretaceous) Ammonoidea from Texas: Jour. Paleontology, vol. 31, pp. 1–33, pls. 1–10, figs. 1–4; also Univ. of Texas, Bur. of Econ. Geol. Rpt. of Invest. no. 28.

———, 1958a, *Graysonites*, a Cretaceous ammonite in Texas: Jour. Paleontology, vol. 32, pp. 171–182, pls. 27–29, figs. 1–3.

——, 1958b, Age of the Austin chalk (Cretaceous): Geol. Soc. Am. bull., vol. 69, p. 1669 (abs.).

——, 1959, Techniques of mollusc zonation in Texas Cretaceous: Am. Jour. Sci., vol. 257, pp. 752–769, 8 text figs.

——, 1960a, Later Cretaceous ammonite successions of the Gulf Coast of the United States: International Geol. Congress, Report of the 21st Session, Norden, part XXI, Other subjects, pp. 251–260, 1 chart.

——, 1960b, Biostratigraphy and the new paleontology: Jour. Paleontology, vol. 34, pp. 347–358.

——, and MARKS, EDWARD, 1952, Zonation of Upper Cretaceous Austin chalk and Burditt marl, Williamson County, Texas: Am. Assoc. Petroleum Geol., vol. 36, pp. 477–488, 1 pl., 2 figs.

Plates 1–82

Text Figures 7–34

PLATE 1

FIGS. *1–4, 9*—*Baculites aquilaensis* Reeside; *1–4,* four views of UT–1365; *9,* UT–964; *all* x1

FIGS. *5, 6*—*Gaudryceras* sp.; ventral and lateral views of WSA–825 (*see also* text fig. 9a), x1

FIGS. *7, 8, 15*—*Bostrychoceras braithwaitei,* n. sp.; *7,* holotype, UT–10619; *8, 15,* UT–30582; *all* x1

FIGS. *10–14, 16–20*—*Glyptoxoceras ellisoni,* n. sp.; *10, 11,* UT–95; *12–14,* UT–10856; *16–18,* WSA–91; *19, 20,* UT–182B; *all,* x1

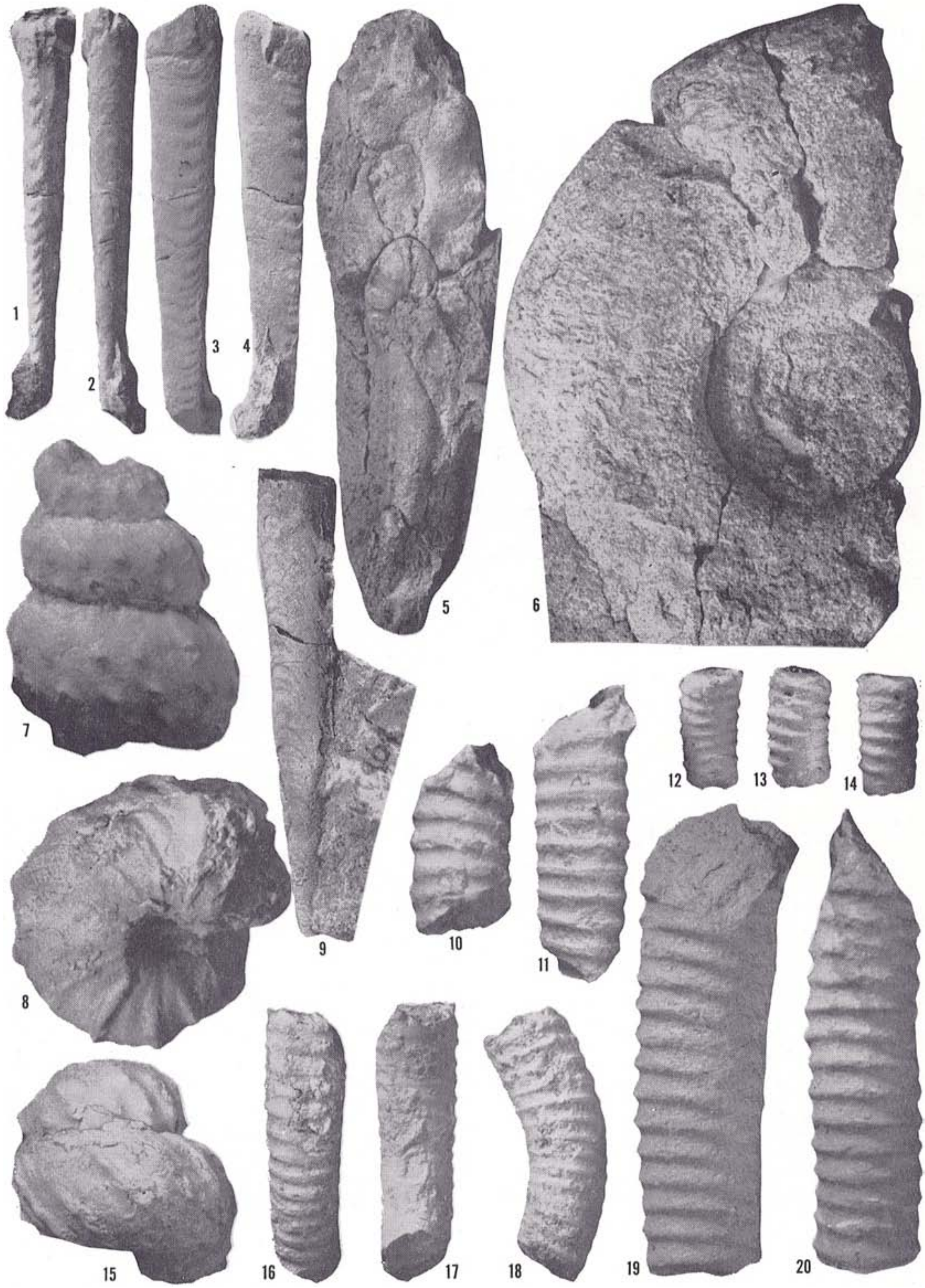

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

PLATE 2

FIGS. *1–4, 6–13*—*Scaphites hippocrepis crassum* Reeside; *all* from collection UT–11260 (*see also* text fig. 7g); x1

FIGS. *5, 15, 17*—*Hoplitoplacenticeras marroti* (Coquand); *5* lateral view of BEG–20496 (*see also* pl. 20, figs. 2, 3, and text fig. 9c); *15, 17*, ventral and lateral views of BEG–20495 (*see also* text fig. 9b); *both* x1

FIGS. *14, 16, 19*—*Manambolites ricensis*, n. sp.; lateral and ventral views of the holotype, UT–10948 (*see also* text figs. 9mp); x1

FIGS. *18, 20–22*—*Baculites* sp. cfr. *B. anceps* Lamarck; *18*, UT–103; *20–22*, from collection UT–30565; *all*, x1

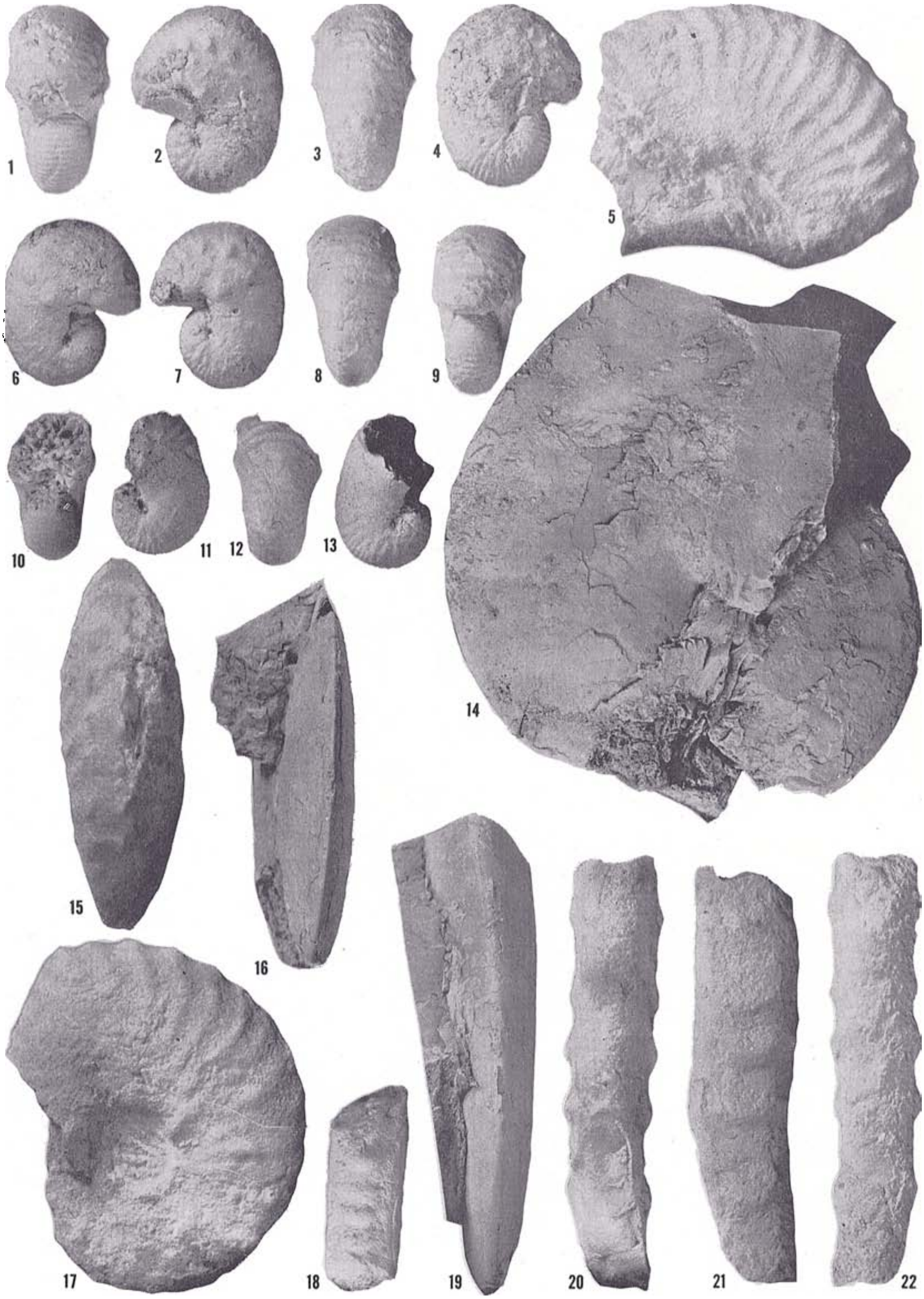

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

PLATE 3

FIGS. *1–5*—*Bostrychoseras secoense*, n. sp. *1*, fragment of body whorl, UT–30507; *2*, *5*, two views of part of whorl, UT–30501; *3*, *4*, two views of the holotype, WSA–662; *1*, *2*, *5*, flattened by sedimentary load; *all* x1


1
2
3
4
5

PLATE 4

FIGS. *1, 6, 7*—*Acanthoscaphites spiniger* (Schlüter); *1*, lateral view of body chamber of UT–19877 (*see also* pl. 5, fig. 4); *6, 7*, lateral and ventral views of UT–19881; *all*, x1

FIGS. *2, 3*—*Phlycticrioceras* sp. cfr. *P. douvillei* (Grossouvre); ventral and lateral views of UT–30589 (*see also* text fig. 7h); x1.

FIGS. *4, 8*—*Bostrychoceras secoense*, n. sp.; *4*, UT–30506, a crushed specimen; *8*, lateral view of UT–1613 (*see also* text fig. 7s); *both*, x1

FIG. *5*—*Exiteloceras* sp.; lateral view of UT–1050 (*see also* pl. 8, fig. 2); x1


1
2
3
4
5
6
7
8

PLATE 5

FIGS. *1, 4, 5*—*Acanthoscaphites spiniger* (Schlüter); *1, 5,* lateral and ventral views of UT–19876; *4,* ventral view of body chamber of UT–19877 (*see also* pl. 4, fig. 1); *all,* x1

FIGS. *2, 3, 6*—*Cirroceras reevesi,* n. sp.; *2, 3,* two views of the holotype, UT–30491 (*see also* text fig. 7k); *6,* UT–30490 (*see also* text fig. 7m); *all,* x1


1
2
3
4
5
6

PLATE 6

FIGS. *1, 4–9*—*Allocrioceras hazzardi,* n. sp.; *1, 4–7, 9,* lateral views and *8,* ventral view; *1, 4, 5, 7, 9,* BEG–20277; *6,* BEG–3300; *5, 8,* holotype, BEG–20277A; *all* x1

FIGS. *2, 3, 10–16*—*Smedaliceras durhami,* n. gen., n. sp.; *2, 3,* ventral and dorsal views of UT–10857 (*see also* text fig. 7d); *10, 11,* dorsal and ventral views of UT–10855 (*see also* text figs. 7ep); *12–14,* dorsal, lateral, and ventral views of the holotype, UT–10860 (*see also* text fig. 7a); *15, 16,* dorsal and lateral views of UT–135 (*see also* text fig. 7c); *all,* x1


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

TEXT FIG. 7

a–e, p—*Smedaliceras durhami*, n. gen., n. sp.; whorl sections of *a*, UT–10860, the holotype (*see also* pl. 6, figs. 12–14); *b*, WSA–56; *c*, UT-135 (*see also* pl. 6, figs. 15, 16); *d*, UT–10857 (*see also* pl. 6, figs. 2, 3); *e*, UT–10855 (*see also* pl. 6, figs. 10, 11, and text fig. 7p); and *p*, suture of UT–10855 (*see also* pl. 6, figs. 10, 11, and text fig. 7e); *all* x1

f, h—*Phlycticrioceras* sp. cfr. *douvillei* (Grossouvre); *f*, whorl section of USNM–73267, and *h*, whorl section of UT–30589 (*see also* pl. 4, figs. 2, 3); *both* x1

g—*Scaphites hippocrepis crassum* Reeside; suture of UT–11260B (*see also* pl. 2, figs. 6–9); x1

j, q–r—*Parapuzosia bösei* Scott and Moore; *j*, suture of and *q*, whorl section of BEG–2307 (*see also* pl. 8, fig. 4, and pl. 9, fig. 2); *r*, whorl section of UT–1952 (*see also* pl. 8, figs. 1, 3); *all*, x1

k, m—*Cirroceras reevesi*, n. sp.; *k*, whorl section of the holotype, UT–30491 (*see also* pl. 5, figs. 2, 3); *m*, whorl section of UT–30490 (*see also* pl. 5, fig. 6); *both*, x1

n—*Pachydiscus* sp. no. 3 cfr. *P. gollevillensis* (d'Orbigny); Suture of WSA–288 (*see also* pl. 14, figs. 2, 3, and text fig. 8h); x1

o—*Menuites stephensoni*, n. sp.; suture of the holotype, WSA–69 (*see also* pl. 15, figs. 1, 2 and text fig. 9n); this is the last suture, marking the end of the phragmacone; x1

s—*Bostrychoceras secoense*, n. sp.; whorl section of UT–1613 (*see also* pl. 4, fig. 8); x1

t—*Pachydiscus* (?) n. sp.; whorl sections of UT–19806 (*see also* pl. 13, figs. 3, 4); x1

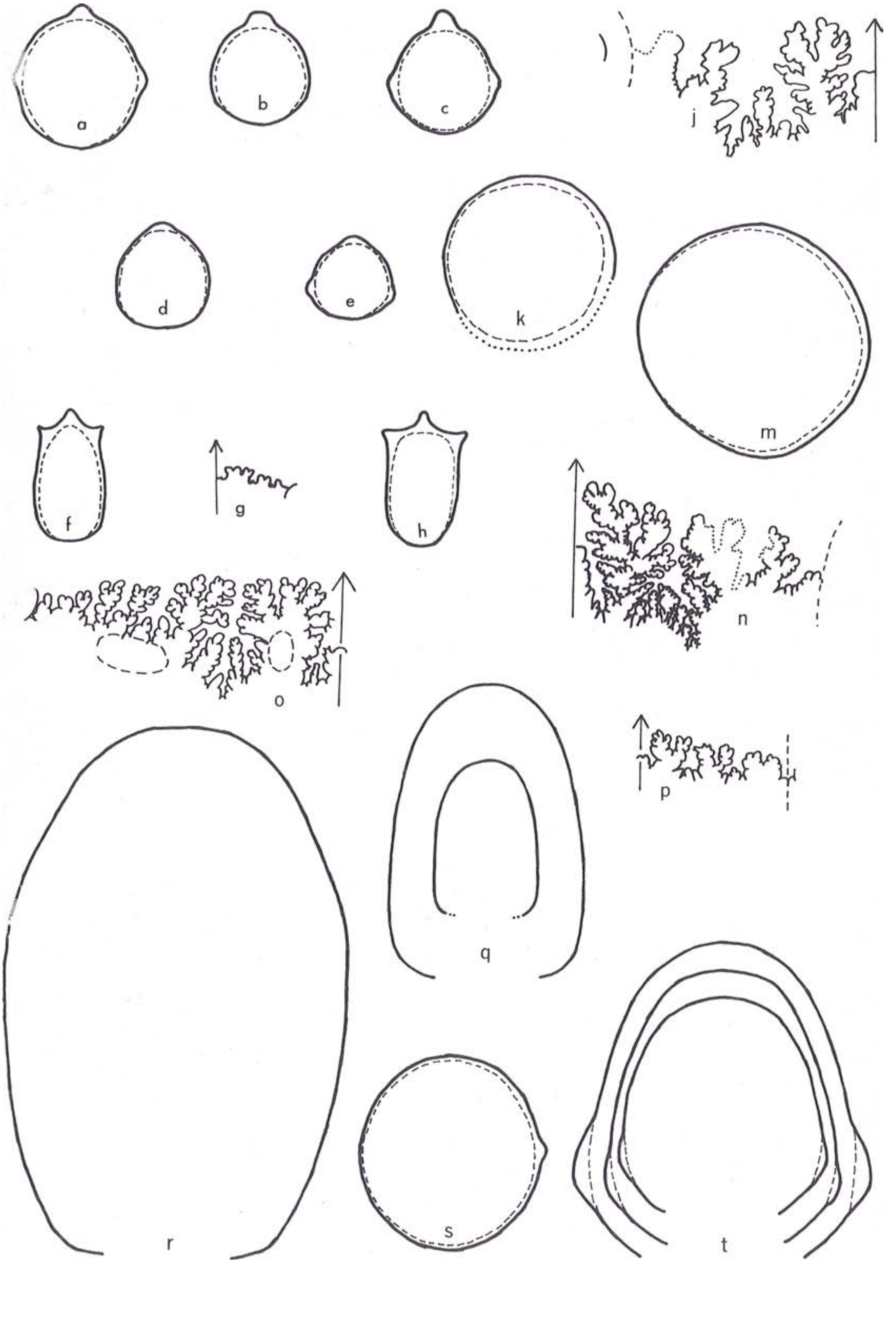

a
b
c
j
d
e
k
m
f
g
h
n
o
p
q
r
s
t

PLATE 7

FIG. *1*—*Parapuzosia bösei* Scott and Moore; lateral view of UT–30546 (*see also* pl. 19, fig. 1); x0.77

FIGS. *2, 3*—*Parapuzosia* sp. aff. *P. bradyi* Miller and Youngquist; ventral and lateral views of inner whorls of UT–30573 (*see also* pl. 9, figs. 1, 3, and text fig. 8d); x1

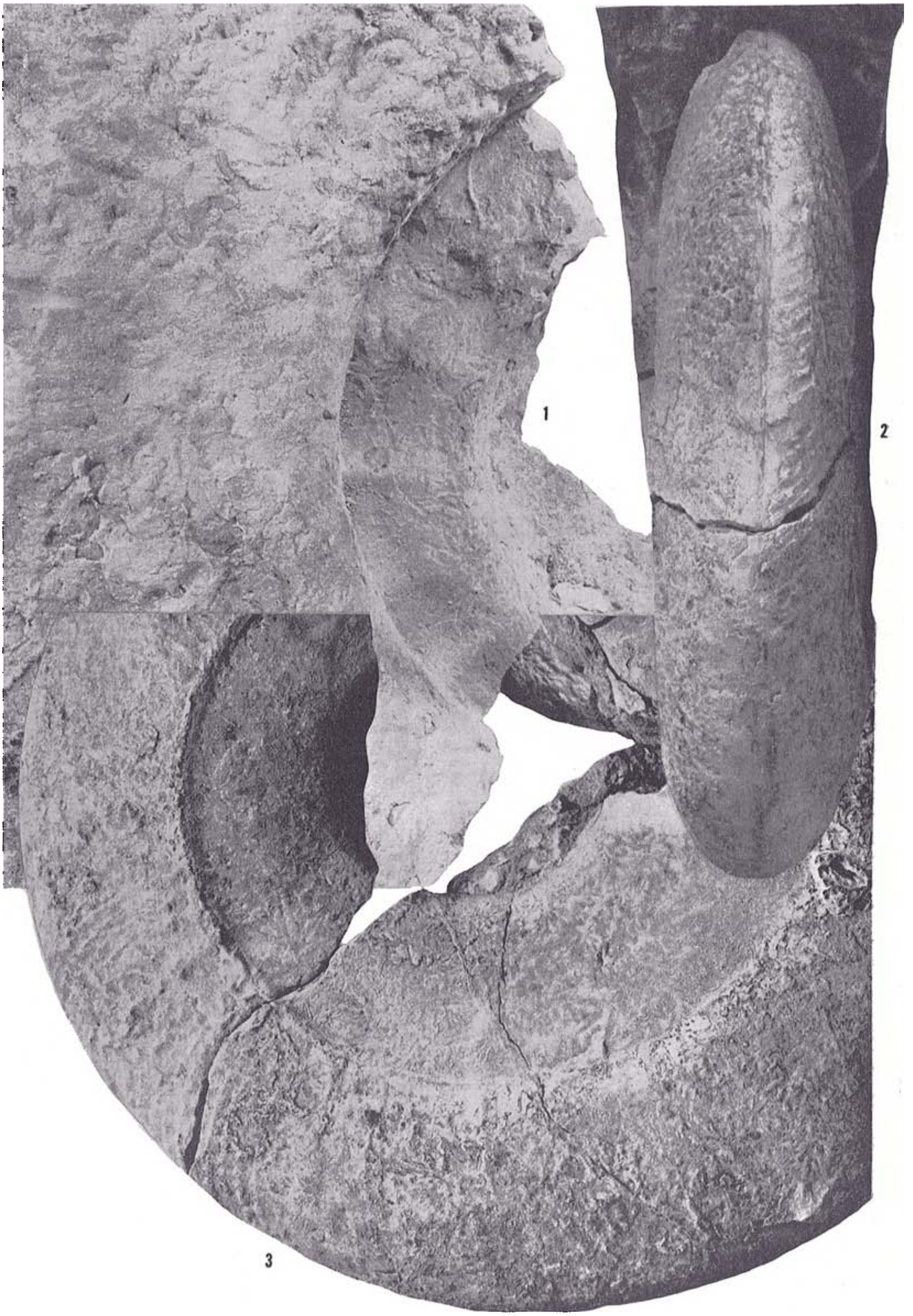

1
2
3

PLATE 8

FIGS. *1, 3, 4*—*Parapuzosia bösei* Scott and Moore; *1, 3,* ventral and lateral views of UT–1952 (*see also* text fig. 7r); *4,* lateral view of BEG–2307 (*see also* pl. 9, fig. 2 and text figs. 7jq); *all,* x1

FIG. *2*—*Exiteloceras* sp.; ventral view of UT–1050 (*see also* pl. 4, fig. 5); x1

FIG. *5*—*Pachydiscus* sp. no. 1 cfr. *P. gollevillensis* (d'Orbigny); ventral view of UT–30516 (*see also* pl. 17, fig. 5, and text figs. 10co); x1

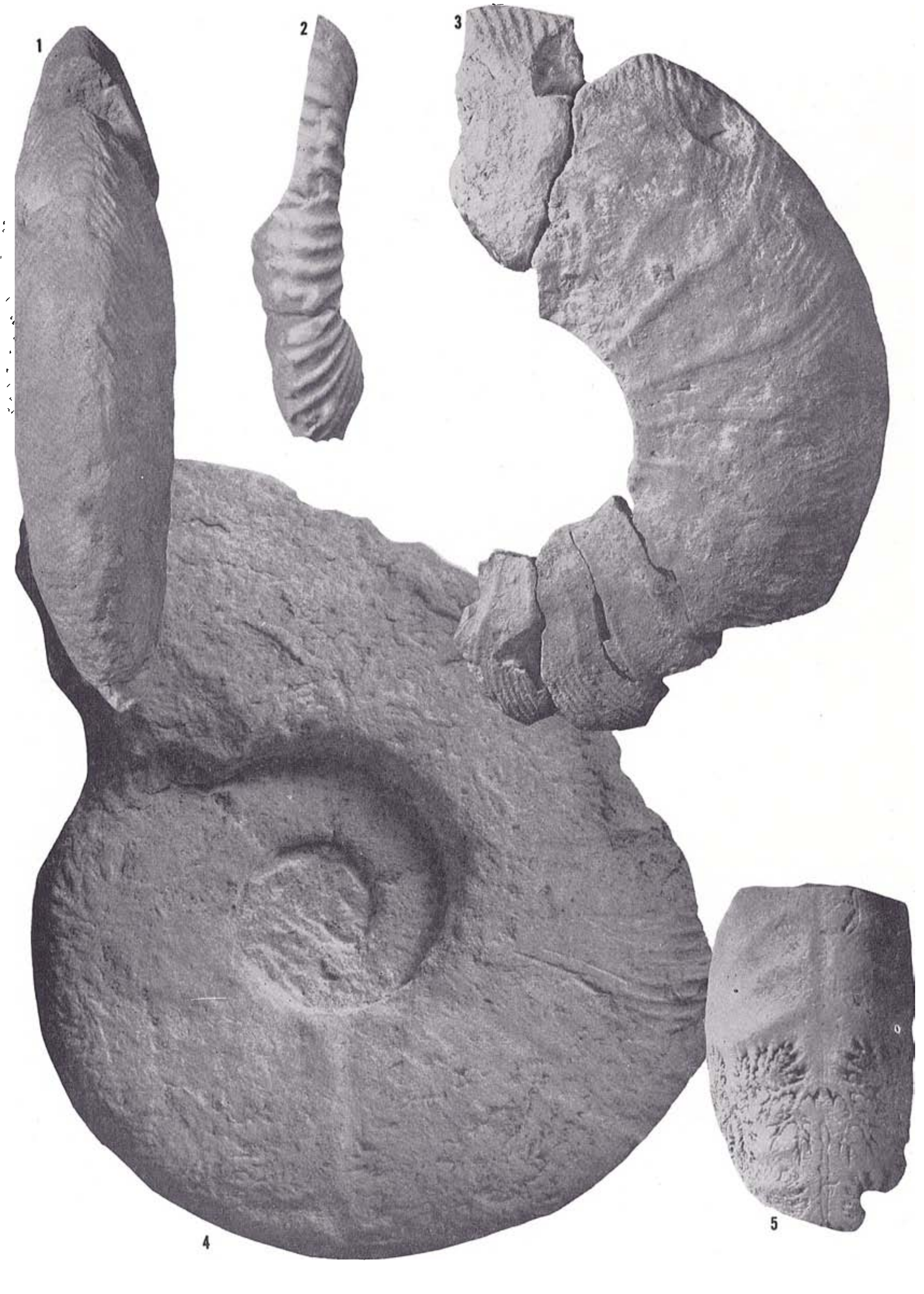

1
2
3
4
5

PLATE 9

FIGS. *1, 3, 4*—*Parapuzosia* sp. aff. *P. bradyi* Miller and Youngquist; *1, 3,* lateral views of UT–30573 (*see also* pl. 7, figs. 2, 3, and text fig. 8d); *4,* ventral view of UT–1521 (*see also* pl. 11, fig. 1); *1,* x0.63; *3,* x0.32; *4,* x0.25

FIG. *2*—*Parapuzosia bösei* Scott and Moore; ventral view of BEG–2307 (*see also* pl. 9 ~~8~~, fig. 4, and text figs. 7jq); x1

1

3

2

4

TEXT FIG. 8

a, b—*Parapuzosia paulsoni,* n. sp.; suture and whorl sections from specimen in Miss Wollman's collection, from the Dessau limestone, zone of *S. tequesquitense* (*see also* pl. 17, fig. 9, and pl. 19, figs. 3, 4); x1

c, g—"*Anapachydiscus*" *complexus* (Hall and Meek); *c*, whorl section of the large example figured by Hall and Meek; *g*, whorl sections of the small example figured by Hall and Meek, at diameters of 8 and 16 mm.; *both* AMNH–9531; *both,* x1

d—*Parapuzosia* sp. aff. *P. bradyi* Miller and Youngquist; whorl sections of UT–30573 (*see also* pl. 7, figs. 2, 3, and pl. 9, figs. 1, 3) at diameters of 120 and 290 mm.; x1

e—*Eupachydiscus gordoni,* n. sp.; whorl sections of the holotype, UT–16 (*see also* pl. 16, figs. 1–3) at diameters of 60 and 75 mm.; x1

f—*Manambolites ricensis,* n. sp., suture of UT–32582 (*see also* pl. 72, fig. 4, pl. 74, fig. 2, and text fig. 11h); x1

h—*Pachydiscus* sp. no. 3 cfr. *P. gollevillensis* (d'Orbigny); whorl sections of WSA–288 (*see also* pl. 14, figs. 2, 3, and text fig. 7n) at diameters of 75 and 120 mm.; x1

j—*Eupachydiscus* sp.; whorl section of WSA–276 (*see also* pl. 18, figs. 1, 2); x1

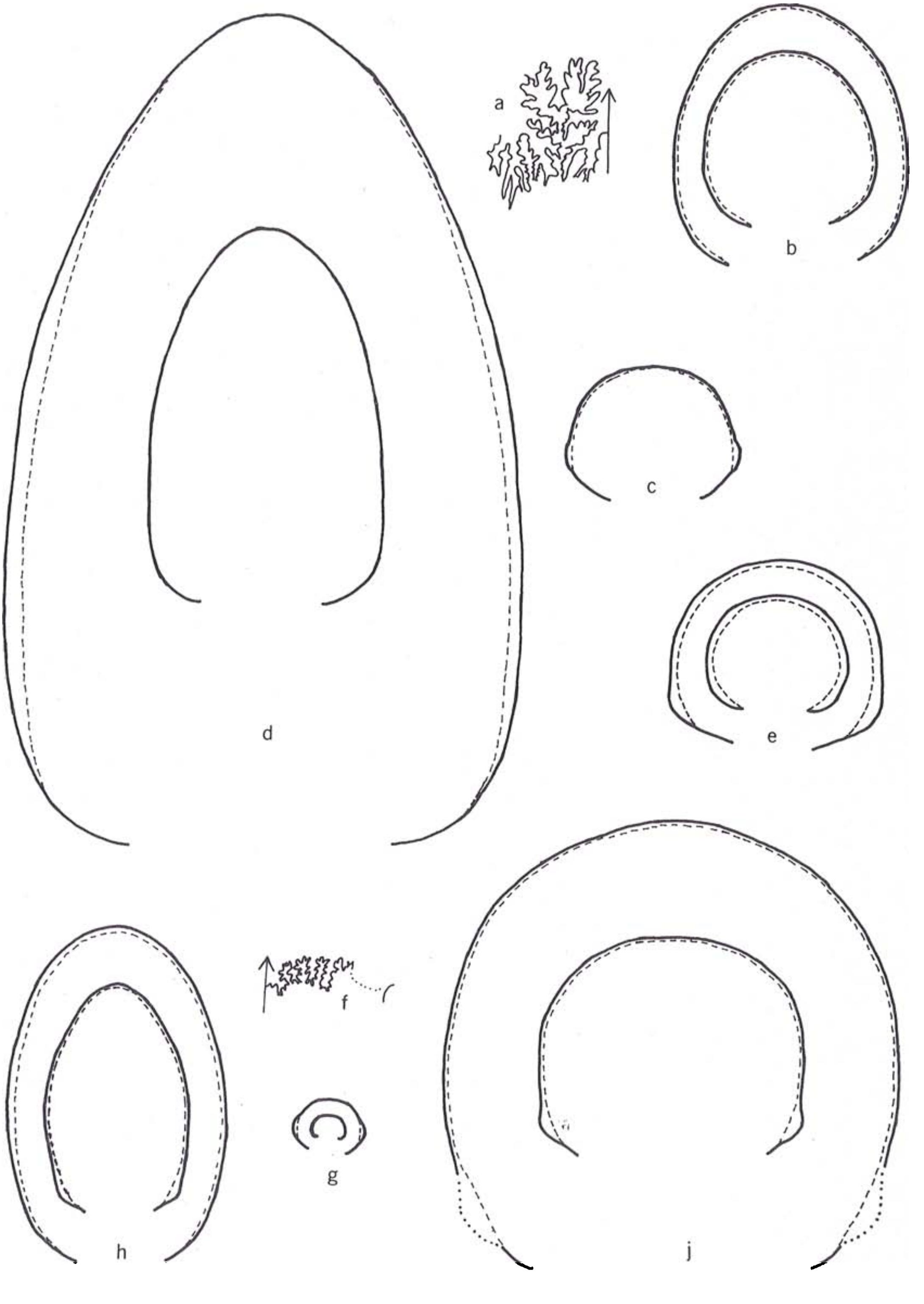

a
b
c
d
e
f
g
h
j

PLATE 10

FIGS. *1, 5*—*Scaphites* sp. cf. *S. hippocrepis crassus* Reeside; lateral and ventral views of UT-30507A; x1

FIGS. *2-4*—*Parapuzosia terryi*, n. sp.; ventral and lateral views of the holotype, UT-30475; *2*, x0.25; *3*, x0.39; *4*, x0.5


1
2
3
4
5

PLATE 11

FIG. *1—Parapuzosia* sp. aff. *P. bradyi* Miller and Youngquist; lateral view of UT–1521 (*see also* pl. 9, fig. 4); x0.25

FIG. *2—Phlycticrioceras* sp. cfr. *P. douvillei* (Grossouvre); lateral view of a fragment, UT–30589, more densely costate than typical forms; x1

FIGS. *3–5—Parapuzosia paulsoni,* n. sp.; *3, 4,* lateral and ventral views of the holotype, UT–30625 (*see also* pl. 12, figs. 1–3; pl. 15, fig. 10, and text fig. 9r); *5,* lateral view of UT–19817B (*see also* pl. 12, fig. 4, and text figs. 9gj); *3, 5,* x1; *4,* x0.5

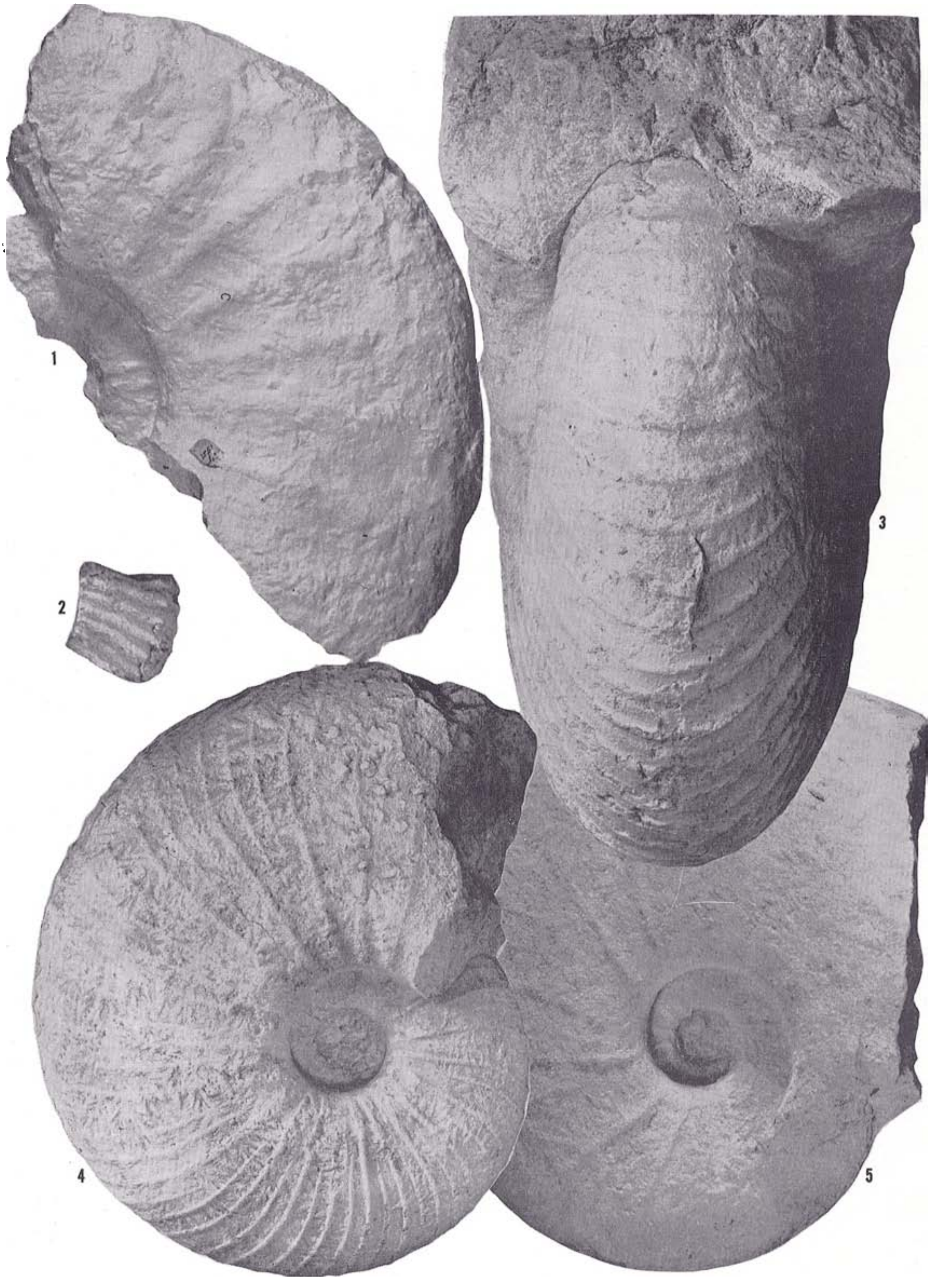

1
2
3
4
5

PLATE 12

FIGS. *1–4*—*Parapuzosia paulsoni,* n. sp.; *1–3,* ventral and lateral views of the holotype, UT–30625 (*see also* pl. 11, figs. 3, 4; pl. 15, fig. 10; and text fig. 9r); *4,* ventral view of UT–19817B (*see also* pl. 11, fig. 5, and text figs. 9gj); *1,* x0.5; *2–4,* x1


1
2
3
4

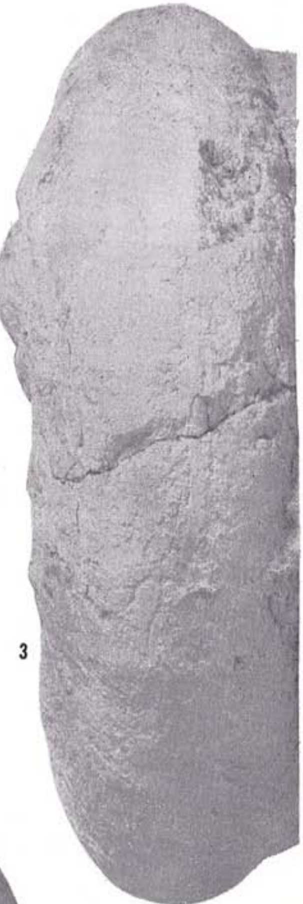
PLATE 13

FIGS. *1, 2, 5*—*Pachydiscus* sp. no. 2 cfr. *P. gollevillensis* (d'Orbigny); *1, 2,* lateral and ventral views of UT–19869 (*see also* text fig. 10d); *5,* ventral view of UT–19870 (*see also* pl. 17, fig. 1, and text fig. 10g); *all* x1

FIGS. *3, 4*—*Pachydiscus* (?) n. sp.; ventral and lateral views of UT–19806 (*see also* text fig. 7t); x1


1


2


3


4

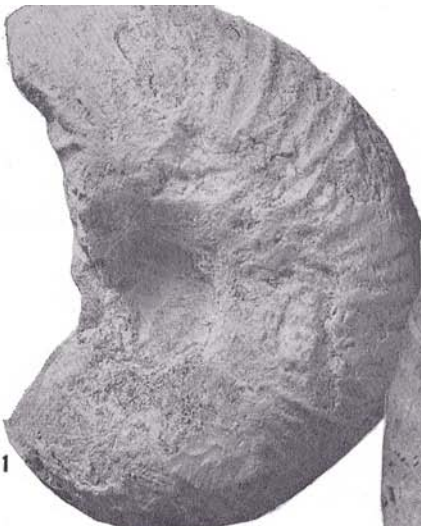

5

PLATE 14

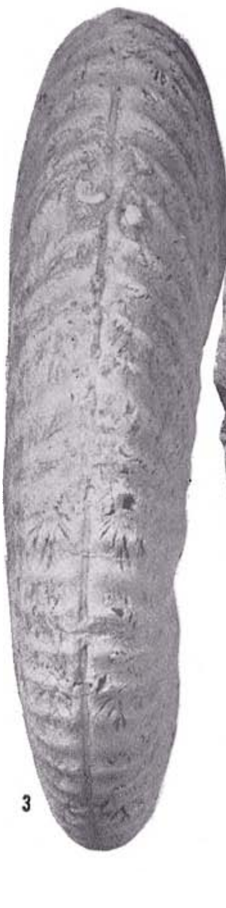
FIGS. *1, 5*—*Eupachydiscus jimenezi* (Renz); lateral views of UT–30496 (*see also* pl. 16, fig. 4, and text fig. 10k); x1

FIGS. *2, 3*—*Pachydiscus* sp. no. 3 cfr. *P. gollevillensis* (d'Orbigny); lateral and ventral views of WSA–288 (*see also* text figs. 7n, 8h); x1

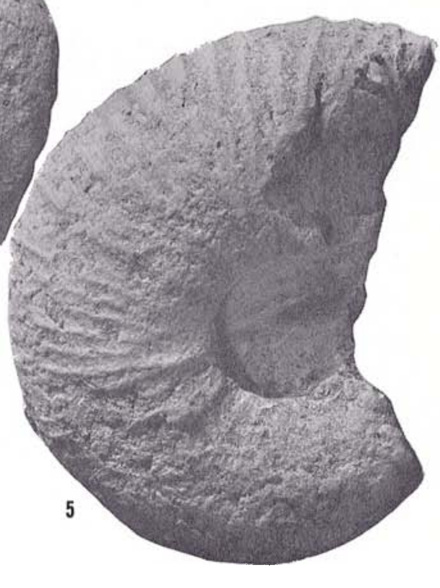
FIG. *4*—*Pachydiscus* sp. no. 2 cfr. *P. gollevillensis* (d'Orbigny); lateral view of UT–30503 (*see also* pl. 17, fig. 8); x1


1


2


3


4


5

TEXT FIG. 9

a—Gaudryceras sp.; whorl sections of WSA-825 (*see also* pl. 1, figs. 5, 6) at diameters of 50 and 100 mm.; x1

b, c, f—Hoplitoplacenticeras marrotti (Coquand); *b,* whorl section of BEG-20495 (*see also* pl. 2, figs. 15, 17) at a diameter of 52.5 mm.; *c,* whorl section of BEG-20496 (*see also* pl. 2, fig. 5, and pl. 20, figs. 2, 3); *f,* whorl section of BEG-34772 (*see also* pl. 21, figs. 1, 4); *all,* x1

d, h, k—Hoplitoplacenticeras sp. aff. *Metaplacenticeras* (?) *bowersi* Anderson; *d,* whorl section of WSA-59; *h, k,* sutures of WSA-59 at diameters of about 20 and 32 mm.; (*see also* pl. 20, figs. 7-9); *all,* x1

e—Exiteloceras sp.; whorl section of BEG-317 (*see also* pl. 20, fig. 12); x1

g, j, i—Parapuzosia paulsoni, n. sp.; *g,* whorl sections of UT-19817B at diameters of 50 and 90 mm., nodes corroded, and *j,* suture of UT-19817B (*see also* pl. 11, fig. 5, and pl. 12, fig. 4) at a diameter of 50 mm.; *i,* whorl sections of the holotype, UT-30625 (*see also* pl. 11, figs. 3, 4; pl. 12, figs. 1-3; and pl. 15, fig. 10), at diameters of 100, 150, and 190 mm.; *all,* x1

m, p—Manambolites ricensis, n. sp.; *m,* suture of UT-10948, the holotype, at a diameter of 50 mm; and *p,* whorl sections of UT-10948, the holotype, at diameters of 44, 63, and 82 mm. (*see also* pl. 2, figs. 14, 16, and 19); x1

n—Menuites stephensoni, n. sp.; whorl sections of the holotype, WSA-69 (*see also* pl. 15, figs. 1, 2, and text fig. 7o), at diameters of 69 and 111 mm., x1

o—"Anapachydiscus" complexus (Hall and Meek); whorl section of an unfigured specimen in the American Museum of Natural History, a paratype, AMNH-9531, at a diameter of about 28 mm.; x1

q—Menuites sp. juv. indet.; whorl section of WSA-60 (*see also* pl. 20, figs. 10, 11), x1

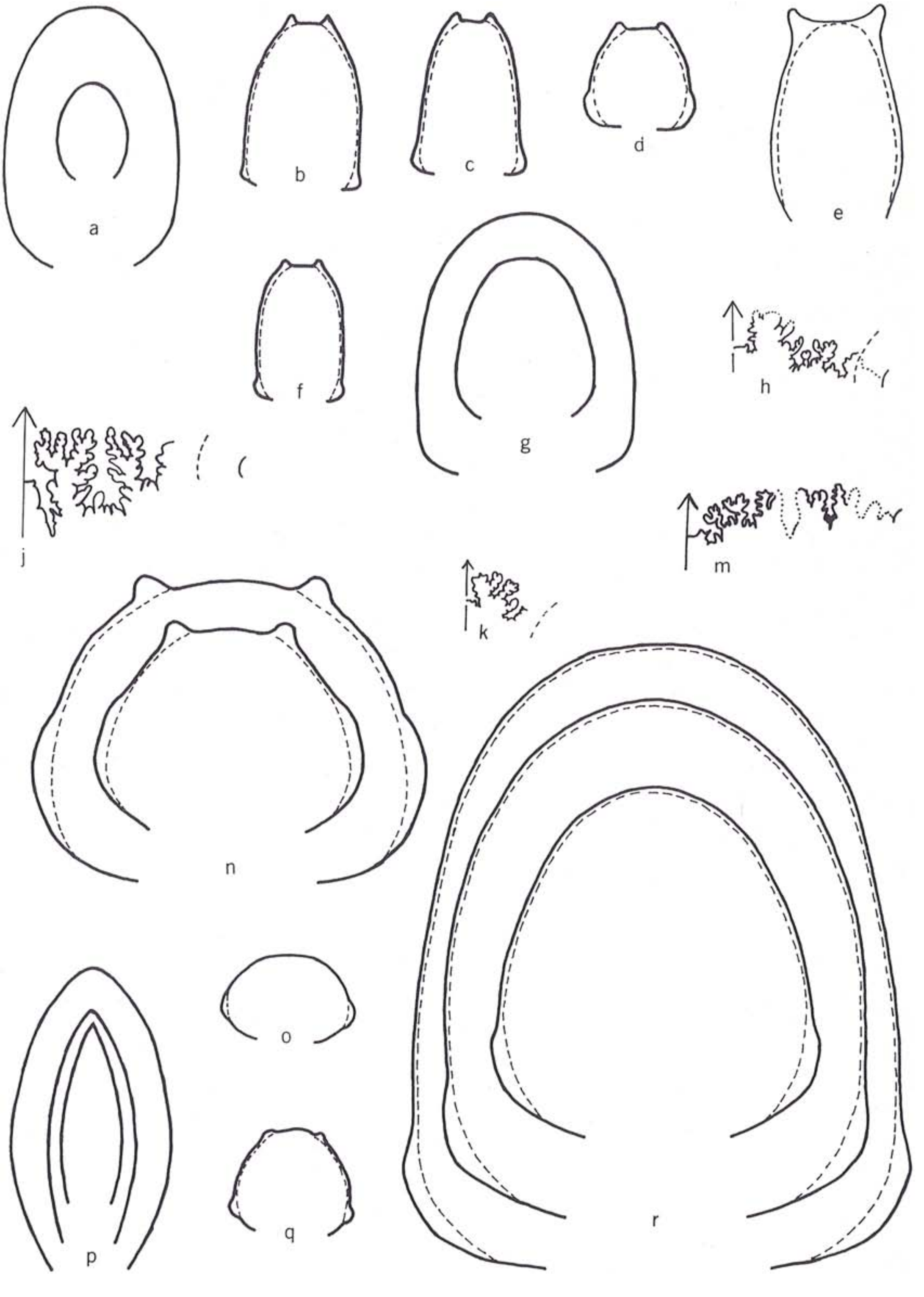

a
b
c
d
e
f
g
h
j
k
m
n
o
p
q
r

PLATE 15

FIGS. *1, 2*—*Mennites stephensoni*, n. sp.; ventral and lateral views of the holotype, WSA-69 (*see also* text figs. 7o and 9n); x1

FIGS. *3–5, 8*—*Pseudoschloenbachia chispaensis* Adkins; *3–5*, lateral and ventral views of a juvenile individual, UT-19800 (*see also* text fig. 11o); *8*, lateral view of UT-19811; *all* x1

FIGS. *6, 7, 9, 11, 12*—*Mennites* sp. juv. indet.; *6, 7*, ventral and lateral views of WSA-62; *9*, ventral view of WSA-61; *11, 12*, lateral and ventral views of WSA-63; *all*, x1

FIG. *10*—*Parapuzosia paulsoni*, n. sp.; ventral view of the holotype, UT-30625 (*see also* pl. 11, figs. 3, 4; pl. 12, figs. 1–3; and text fig. 9r); x0.5

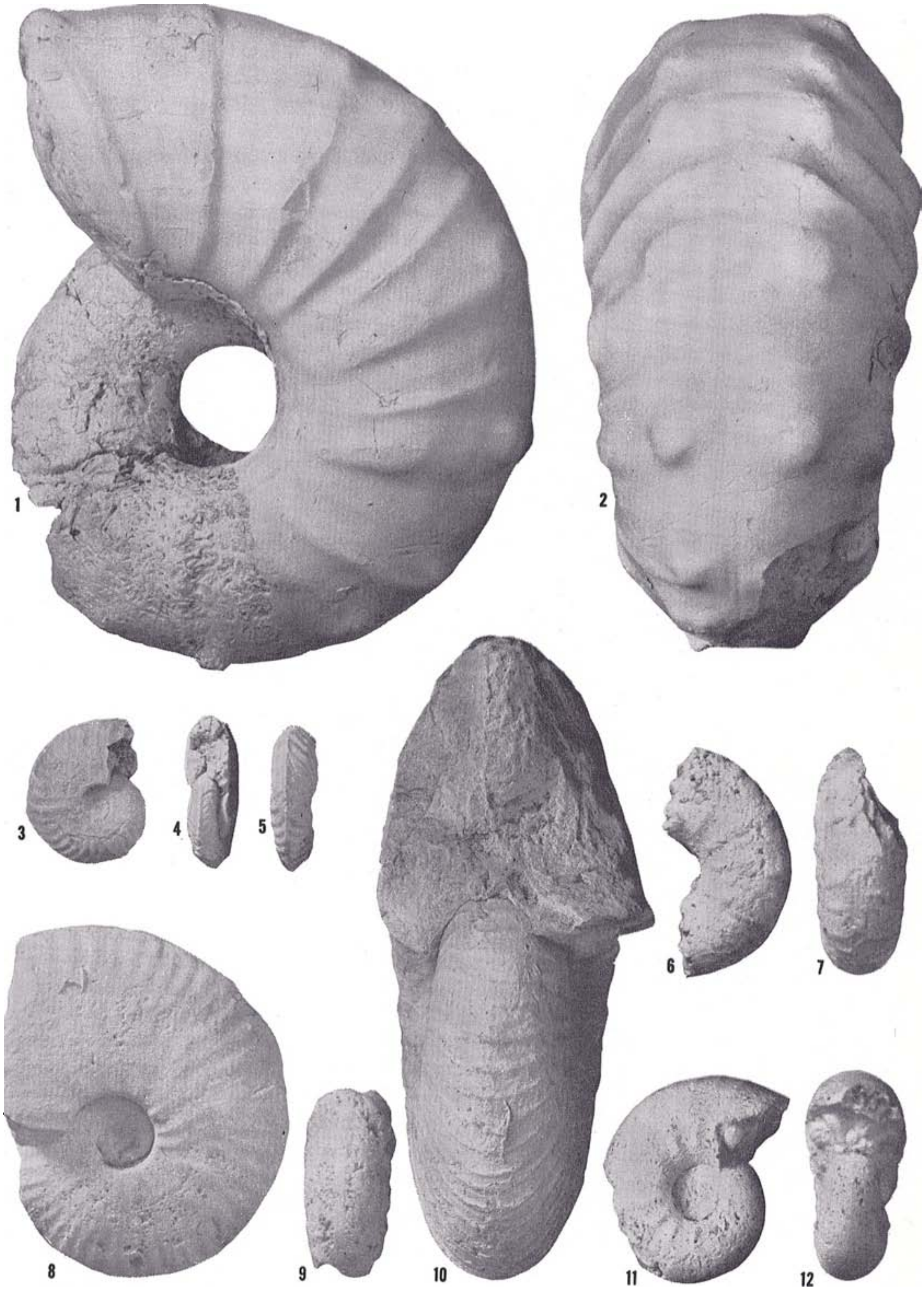

1
2
3
4
5
6
7
8
9
10
11
12

PLATE 16

FIGS. *1–3—Eupachydiscus gordoni,* n. sp.; ventral and lateral views of the holotype, UT–16 (*see also* text fig. 8e); x1

FIG. *4—Eupachydiscus jimenezi* (Renz); ventral view of UT–30496 (*see also* pl. 14, figs. 1, 5, and text fig. 10k); x1

FIGS. *5, 6—Nowakites* ? sp. cfr. *N. flaccidicostus* (Römer); ventral and lateral views of UT–19805 (*see also* pl. 76, fig. 5); x1


1
2
3
4
5
6

PLATE 17

FIGS. *1, 8*—*Pachydiscus* sp. no. 2 cfr. *P. gollevillensis* (d'Orbigny); *1*, lateral view of UT–19870 (*see also* pl. 13, fig. 5, and text fig. 10g); *8*, ventral view of UT–30503 (*see also* pl. 14, fig. 4); *all*, x1

FIGS. *2, 7*—*Eupachydiscus* sp.: lateral and ventral views of UT–19871 (*see also* text fig. 10f); x1

FIGS. *3, 4*—*Hoplitoplacenticeras marrotti* (Coquand); lateral and ventral views of BEG–34774 (*see also* pl. 81, fig. 4, and text fig. 11a); x1

FIG. *5*—*Pachydiscus* sp. no. 1 cfr. *P. gollevillensis* (d'Orbigny); lateral view of UT–30516 (*see also* pl. 8, fig. 5, and text figs. 10co), x1

FIG. *6*—*Stantonoceras sancarlosense* (Hyatt); ventral view of UT–30726 (*see also* pl. 21, fig. 7 and pl. 78, fig. 2); x1

FIG. *9*—*Parapuzosia paulsoni*, n. sp.; ventral view of specimen in Miss Constance Wollman's collection from the Dessau limestone (*see also* pl. 19, figs. 3, 4, and text figs. 8ab); x1


1
2
3
4
5
6
7
8
9

TEXT FIG. 10

a, f—*Eupachydiscus* sp.; *a*, whorl sections of WSA–278 (*see also* pl. 18, fig. 3, and pl. 19, fig. 2); *f*, whorl section of UT–19871 (*see also* pl. 17, figs. 2, 7) at diameters of 55 and 75 mm.; *both*, x1

b—*Nowakites flaccidicostus* (Romer); whorl section after Romer (1852, pl. 1, fig. 1b); x1

c, o—*Pachydiscus* sp. no. 1 cfr. *P. gollevillensis* (d'Orbigny); suture and whorl section of UT–30516 (*see also* pl. 8, fig. 5, and pl. 17, fig. 5); x1

d, g—*Pachydiscus* sp. no. 2, cfr. *P. gollevillensis* (d'Orbigny); *d*, whorl sections of UT–19869 (*see also* pl. 13, figs. 1, 2) at diameters of 60 and 80 mm.; *g*, whorl sections of UT–19870 (*see also* pl. 13, fig. 5, and pl. 17, fig. 1) at diameters of 75 and 150 mm.; *all*, x1

e, n—*Pseudoschloenbachia chispaensis* Adkins; *e*, whorl sections of UT–19820 (*see also* pl. 76, figs. 1, 3) at diameters of 60, 75, and 100 mm.; *n*, suture of the holotype, BEG–3009 (*see also* pl. 76, figs 2, 4, and text fig. 11d) at a diameter of 55 mm.; *all*, x1

h, p, q—*Texasia dentatocarinata* (Romer); *h*, whorl section of UT–19873 (*see also* pl. 73, figs. 1, 2); *p*, whorl section of WSA–65 (*see also* pl. 72, figs. 1, 2, 7) at a diameter of 65 mm.; *q*, whorl sections of UT–30558, a cast of the holotype (*see also* pl. 72, figs. 3, 6; pl. 73, figs. 5, 6; and text fig. 11b), at diameters of 50 and 75 mm.; *all*, x1

j, m—*Pseudoschloenbachia wilsoni*, n. sp.; *j*, whorl section of UT–28 (*see also* pl. 75, figs. 5, 7, 8) at a diameter of 50 mm.; *m*, whorl section of the holotype, UT–30596 (*see also* pl. 73, fig. 7, and pl. 75, fig 9), at a diameter of 55 mm.; *both*, x1

k—*Eupachydiscus jimenezi* (Renz); whorl sections of UT—30496 (*see also* pl. 14, figs. 1, 5, and pl. 16, fig. 4) at diameters of 45 and 75 mm.; x1

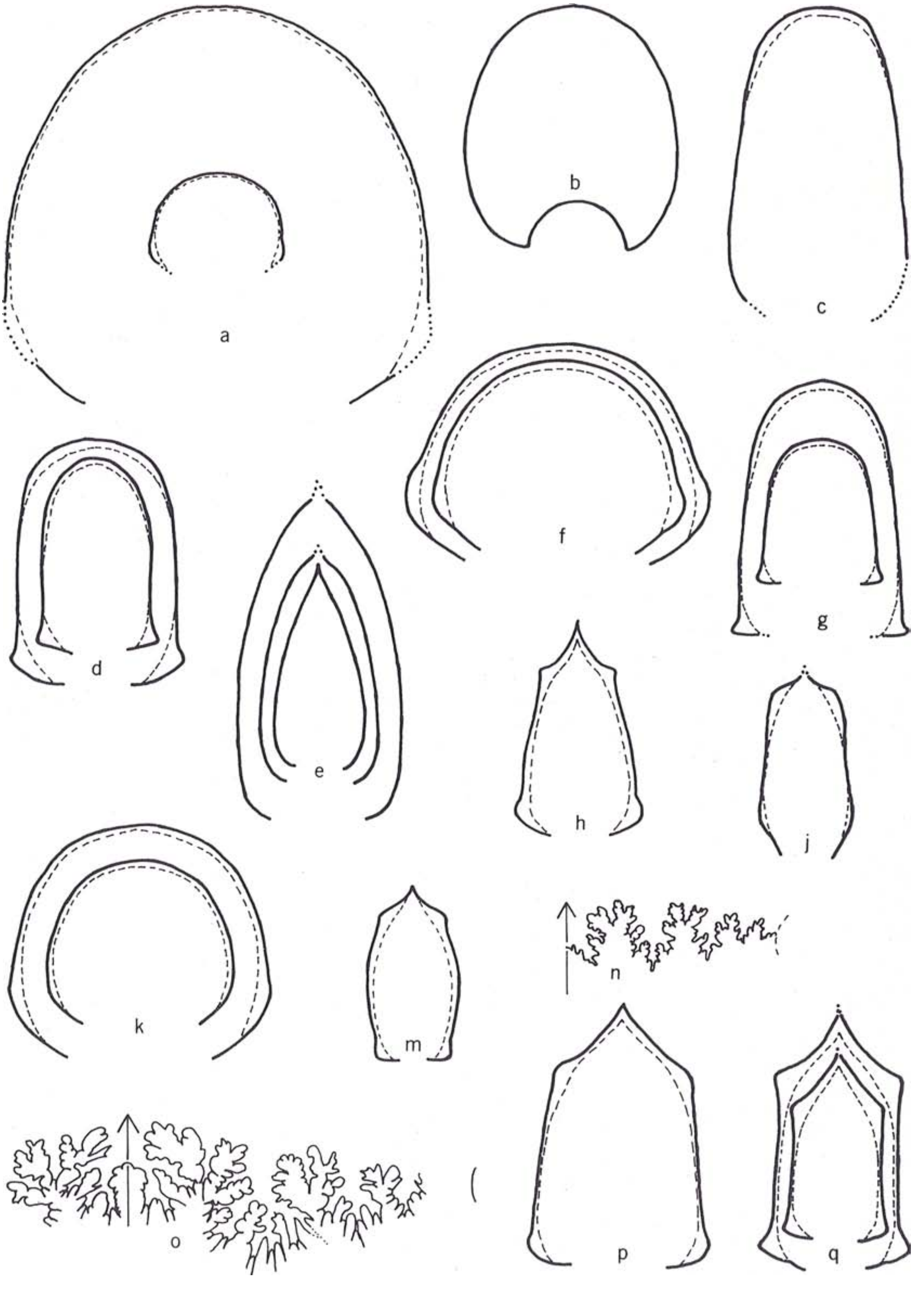

a
b
c
d
e
f
g
h
j
k
m
n
o
p
q

PLATE 18

FIGS. *1–3*—*Eupachydiscus* sp. *1, 2,* lateral and ventral views of WSA–276 (*see also* text fig. 8j); *3,* lateral view of WSA–278 (*see also* pl. 19, fig. 2, and text fig. 10a); *both,* x1

FIG. *4*—*Bostrychoceras* sp. cfr. *braithwaitei,* n. sp.; lateral view of UT–32695; x1


1
2
3
4

PLATE 19

FIG. *1*—*Parapuzosia bösei* Scott and Moore; lateral view of UT–30546 (*see also* pl. 7, fig. 1); x0.24

FIG. *2*—*Eupachydiscus* sp.; ventral view of WSA–278 (*see also* pl. 18, fig. 3, and text fig. 10a); x1

FIGS. *3, 4*—*Parapuzosia paulsoni,* n. sp.; ventral and lateral views of specimen in Miss Wollman's collection (*see also* pl. 17, fig. 9, and text figs. 8ab); x1


1
2
3
4

PLATE 20

FIGS. *1, 4—Muniericeras ? twiningi*, n. sp.; lateral and ventral views of the holotype, UT–30500 (*see also* text fig. 11q); x1

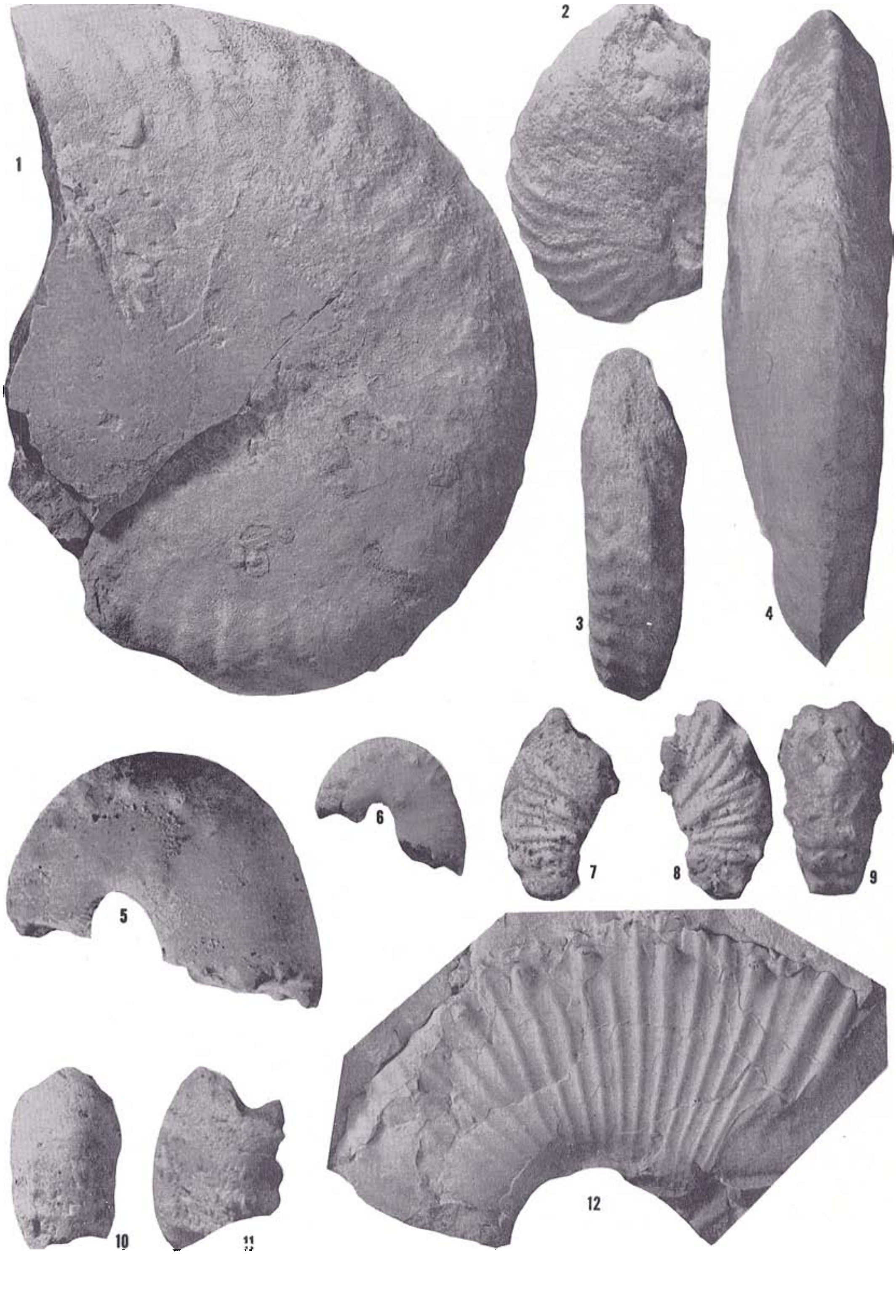
FIGS. *2, 3—Hoplitoplacenticeras marroti* (Coquand); lateral and ventral views of BEG–20496 (*see also* pl. 2, fig. 5, and text fig. 9c); x1

FIGS. *5, 6—Scaphites* sp. cfr. *S. leei* Reeside; lateral views of UT–105; *5*, x2; *6*, x1

FIGS. *7–9—Hoplitoplacenticeras* sp. aff. *Metaplacenticeras* (?) *bowersi* Anderson; lateral and ventral views of WSA–59 (*see also* text figs. 9dhk); x1

FIGS. *10, 11—Menuites* sp. juv. indet.; ventral and lateral views of WSA–60 (*see also* text fig. 9q), x1

FIG. *12—Exiteloceras* sp.; lateral view of BEG–317 (*see also* text fig. 9e); x1


1
2
3
4
5
6
7
8
9
10
11
12

TEXT FIG. 11

a—*Hoplitoplacenticeras marroti* (Coquand); whorl section of BEG–34774 (*see also* pl. 17, figs. 3, 4, and pl. 81, fig. 4); x1

b—*Texasia dentatocarinata* (Romer); suture of the holotype, after Römer's (1852) pl. 1, fig. 2c (*see also* pl. 72, figs. 3, 6; pl. 73, figs. 5, 6; and text fig. 10q); x1

c, g, m, s—*Eulophoceras wollmanae*, n. sp.; *c*, whorl section and *m*, suture of smaller specimen in Miss Wollman's collection (*see also* pl. 74, figs. 1, 4, 6); *g, s*, suture and whorl sections of the holotype, the larger specimen in Miss Wollman's collection (*see also* pl. 72, fig. 5, and pl. 74, figs. 3 and 5); *all*, x1

d, j, k, o, p, r—*Pseudoschloenbachia chispaensis* Adkins; *d*, whorl section of the holotype, BEG–3009 (*see also* pl. 76, figs. 2, 4, and text fig. 10n) at a diameter of 56 mm.; *j*, whorl sections of UT–30602 at diameters of 25 and 58 mm.; *k*, whorl sections of UT–19888 (*see also* pl. 75, fig. 3, and pl. 76, fig. 6); *o*, whorl sections of UT–19800 (*see also* pl. 15, figs. 3–5) at diameters of 15 and 20 mm.; *p*, suture of UT–19816 (*see also* pl. 75, figs. 2, 4) at a diameter of 65 mm.; *r*, suture of UT–19803 (*see also* pl. 75, fig. 1) at a diameter of 88 mm.; *all*, x1

e, f—*Submortoniceras chicoense* (Taff); whorl sections from 2 specimens in the USNM from U. S. G. S. Mesozoic locality 1239, for comparison; x1

h—*Manambolites ricensis*, n. sp.; whorl sections of UT–32582 (*see also* pl. 72, fig. 4, pl. 74, fig. 2, and text fig. 8f); x1

n—*Pseudoschloenbachia* n. sp. indet.; suture of WSA–948; x1

q—*Muniericeras ? twiningi*, n. sp.; whorl sections of the holotype, UT–30500 (*see also* pl. 20, figs. 1, 4); x1

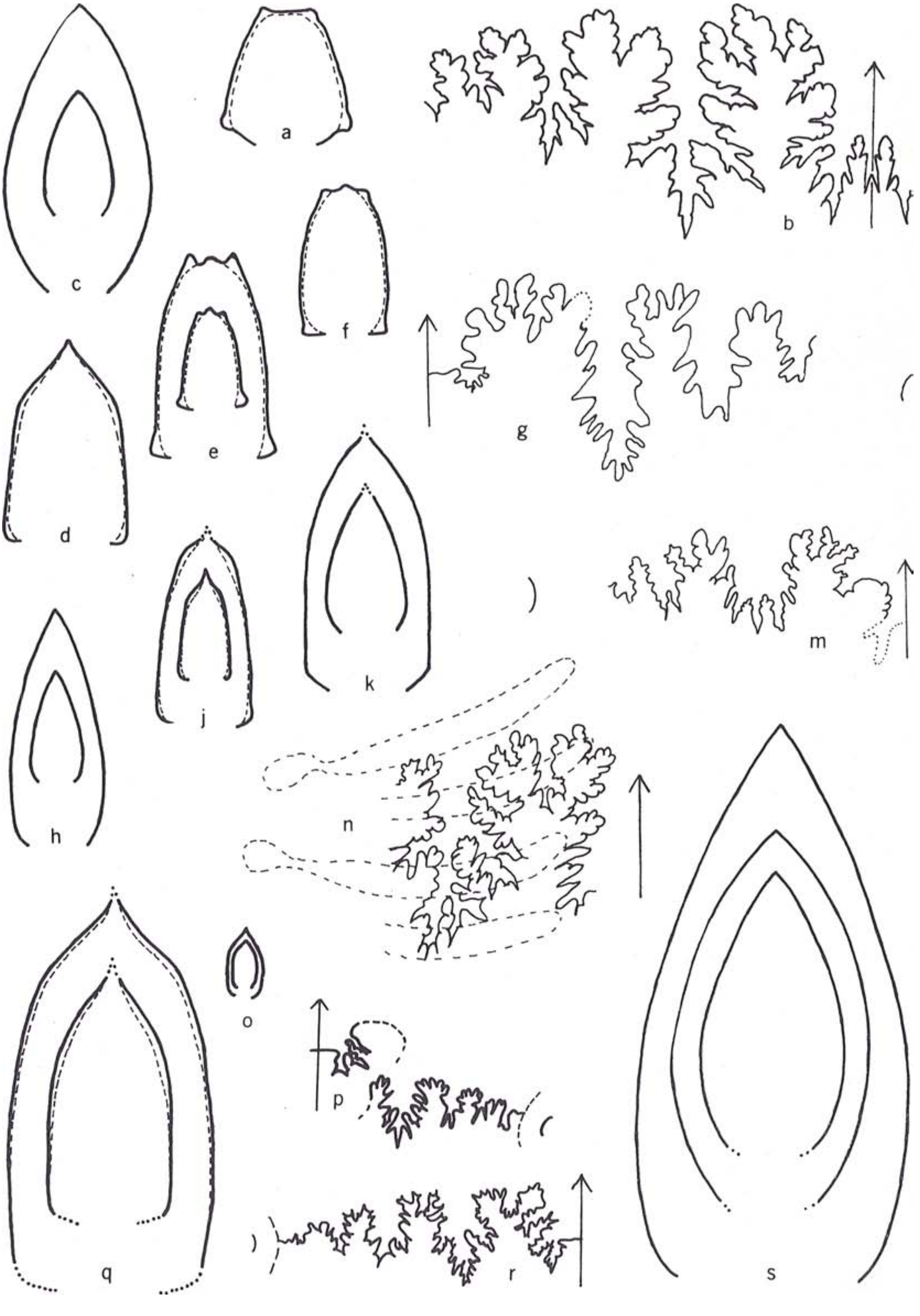

a
b
c
d
e
f
g
h
j
k
m
n
o
p
q
r
s

PLATE 21

FIGS. *1, 4*—*Hoplitoplacenticeras marroti* (Coquand); lateral and ventral views of BEG–34772 (*see also* text fig. 9f); x1

FIGS. *2, 3, 6*—*Placenticeras* (*Stantonoceras*) *guadalupae* (Römer); lateral and ventral views of UT–168; x0.5

FIGS. *5, 8*—*Pycnodonte aucella* (Römer); *5,* interior of left valve of UT–10357 (*see also* pl. 78, fig. 7); *8,* exterior of left valve of UT–1722 (*see also* pl. 79, fig. 2); *both,* x1

FIG. *7*—*Stantonoceras sancarlosense* (Hyatt); lateral view of UT–30726 (*see also* pl. 17, fig. 6, and pl. 78, fig. 2); x1

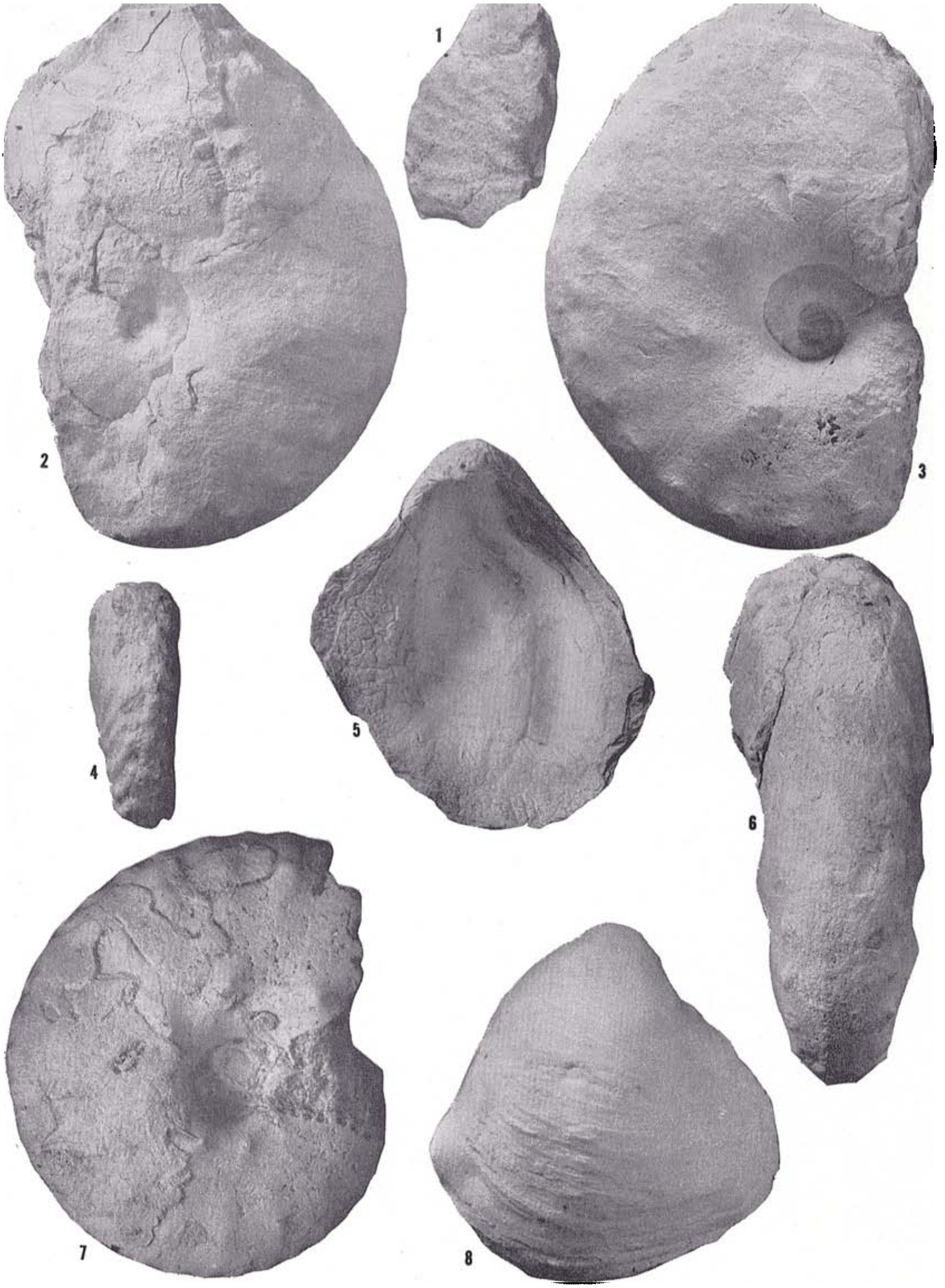

1
2
3
4
5
6
7
8

PLATE 22

FIGS. *1, 2*—*Stantonoceras sancarlosense* (Hyatt); ventral and lateral views of UT–167; x0.5

FIG. *3*—*Pycnodonte aucella* (Römer); external view of left valve of UT–10351 (*see also* pl. 79, fig. 6), x1

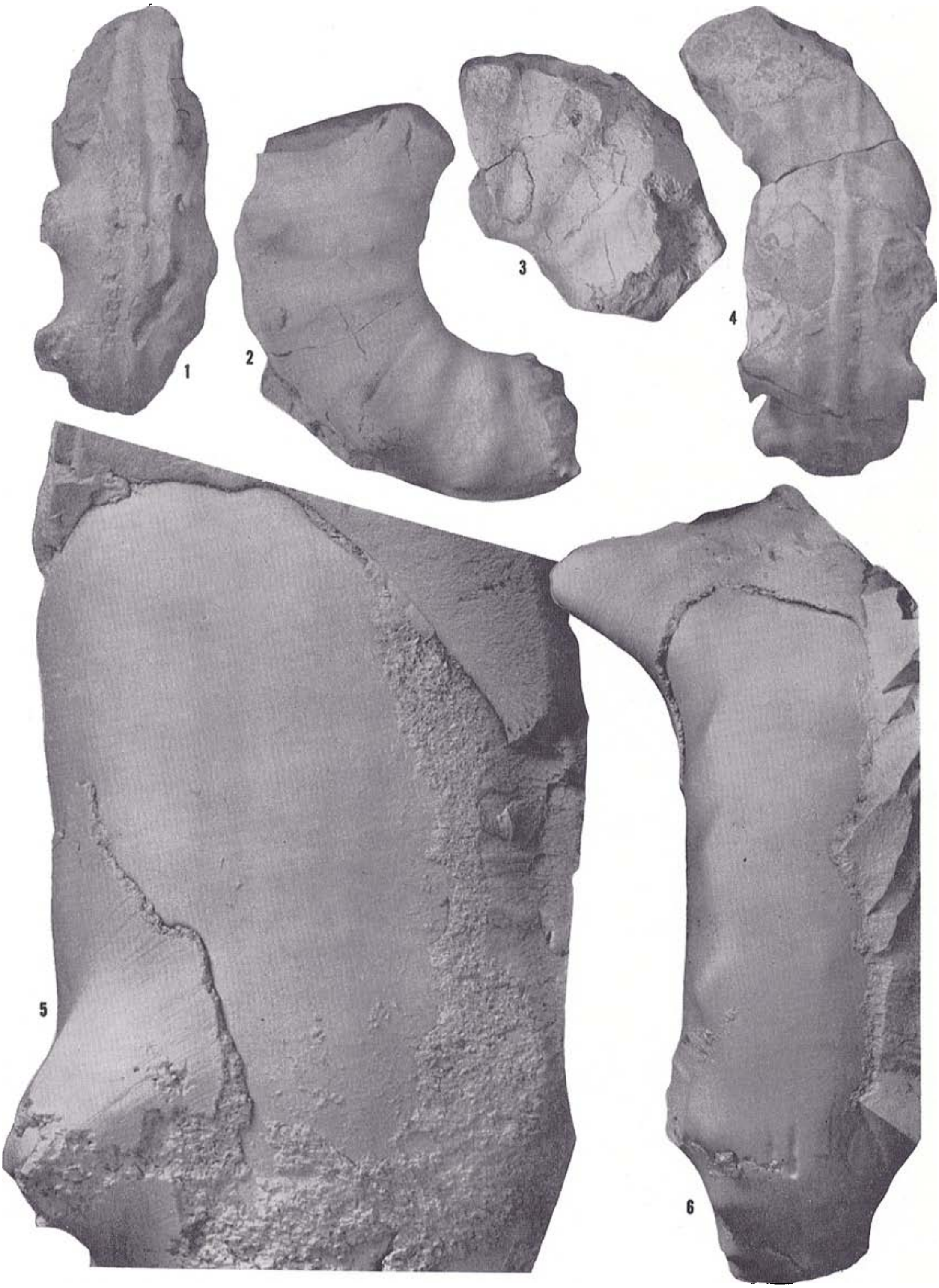
FIGS. *4, 5*—*Stantonoceras pseudosyrtale* (Hyatt); lateral and ventral views of UT–10167; *4*, x0.61; *5*, x0.74


1
2
3
4
5

PLATE 23

FIGS. *1–4—Prionocycloceras adkinsae*, n. sp.; *1, 3, 4*, ventral and lateral views of three individuals from collection WSA–94 (*see also* text figs. 28g and 34e); *2*, lateral view of the holotype, WSA–94A (*see also* text fig. 25f); *all*, x1

FIGS. *5, 6—Prionocycloceras guayabanum* (Steinmann in Gerhardt); ventral views of WSA–137 (*see also* pl. 27, figs. 2, 3, and text figs. 12a and 33d); *5*, x1; *6*, x0.5


1
2
3
4
5
6

TEXT FIG. 12

a—*Prionocycloceras guayabanum* (Steinmann in Gerhardt): whorl sections of WSA–137 (*see also* pl. 23, figs. 5, 6; pl. 27, figs. 2, 3; and text fig. 33d), at diameters of 135 and 215 mm.; x1

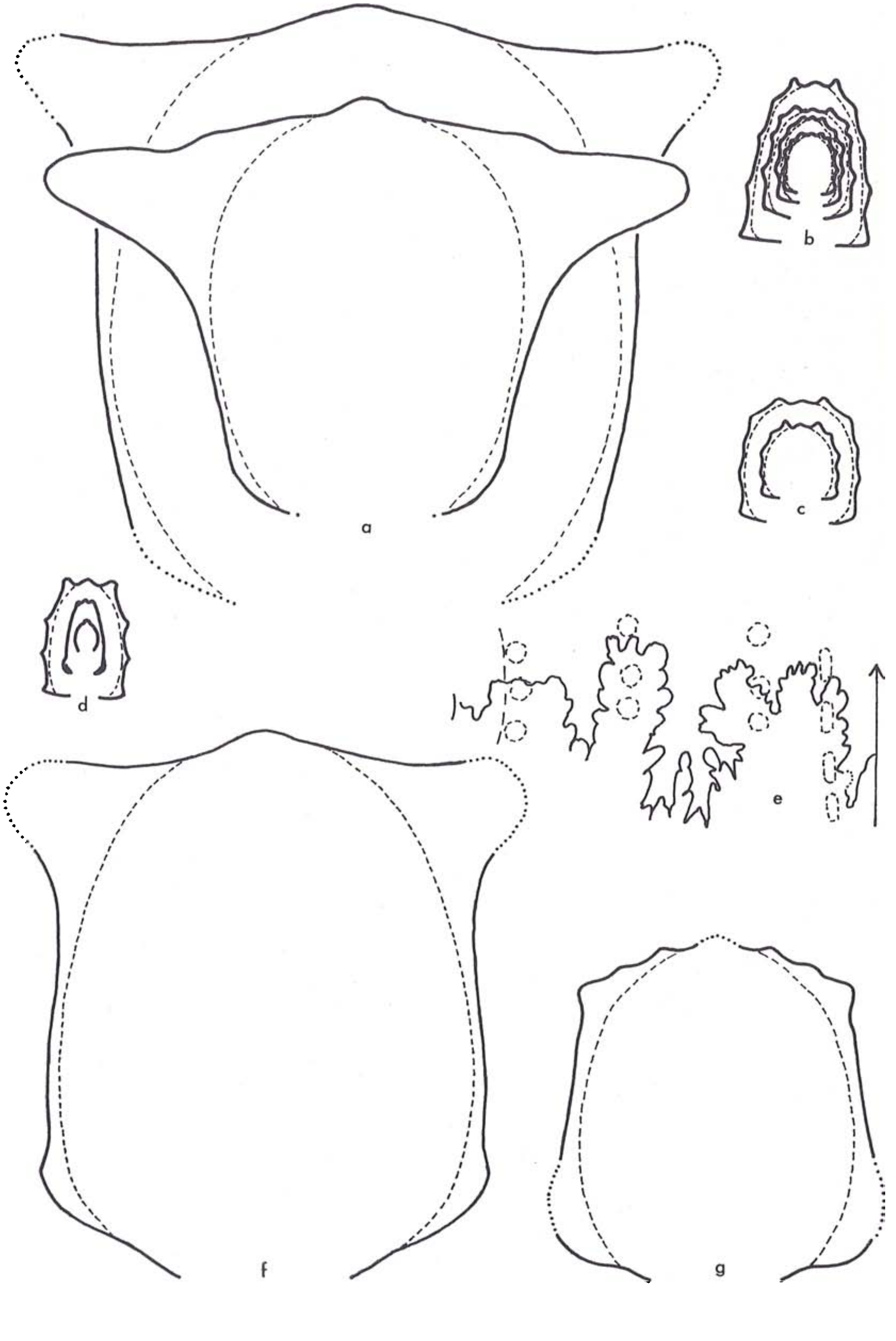
b—*Submortoniceras tequesquitense*, n. sp.; whorl sections of UT–1600 (*see also* pl. 51, figs. 1, 2; pl. 52, fig. 3), at diameters of 20, 30, 40, and 60 mm.; x1

c, e—*Submortoniceras vanuxemi* (Morton); *c*, whorl sections of the individual figured by Whitfield (1892, pl. 42, figs. 3, 4) at diameters of 30 and 50 mm.; *e*, suture from corroded individual, UT–30607 (*see also* pl. 57, fig 7, and pl. 69, fig. 6, and text fig. 26d); *both*, x1

d—*Submortoniceras chicoense* (Trask); whorl sections of WSA–64 (*see also* pl. 57, figs. 1–3) at diameters of 10, 21, and 40 mm.; x1

f—*Prionocycloceras hazzardi*, n. sp.; whorl section of BEG–20498 (*see also* pl. 26, figs. 1, 2; pl. 27, fig. 4; and text fig. 13d to compare differences in restoration), width restored; x1

g—*Peroniceras* sp.; whorl section of UT–30611; x1


a
b
c
d
e
f
g

TEXT FIG. 13

a—*Peroniceras moureti* Grossouvre; whorl sections of UT–19937 (*see also* pl. 26, fig. 5, and pl. 27, fig. 1) at diameters of 100 and 150 mm.; x1

b, d—*Prionocycloceras hazzardi*, n. sp.; *b*, whorl sections of BEG–34740 (*see also* pl. 24, fig. 4; pl. 25, fig. 2; and text fig. 14g) at diameters of 330 and 515 mm.; *d*, whorl sections of BEG–20498 (*see also* pl. 26, figs. 1, 2; pl. 27, fig. 4; and text fig. 12f, to compare differences in restoration), whorl width restored and probably inaccurate; *b*, x0.5; *d*, x1

c—*Protexanites shoshonense* (Meek) *crassum* Reeside; whorl sections of USNM–73272, illustrated by Reeside (1927) on pl. 8, figs. 5–8; x1

e—*Pseudoschloenbachia mexicana* (Renz); whorl sections of WSA–247 (*see also* pl. 30, fig. 4), at diameters of 30 and 65 mm.; x1

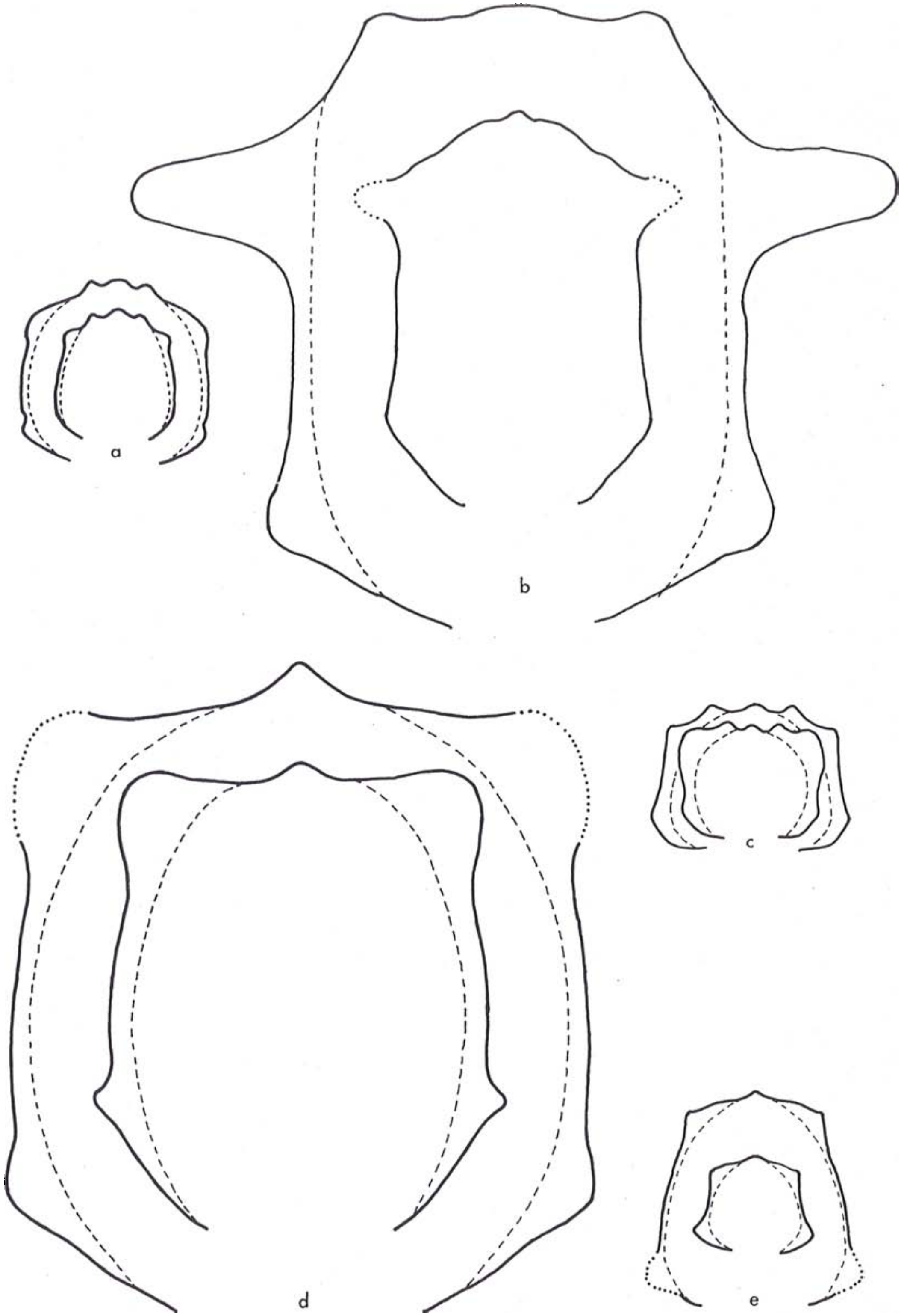
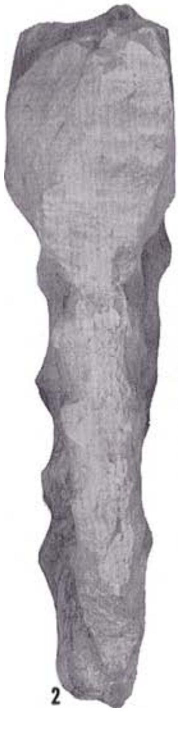

a
b
c
d
e

PLATE 24

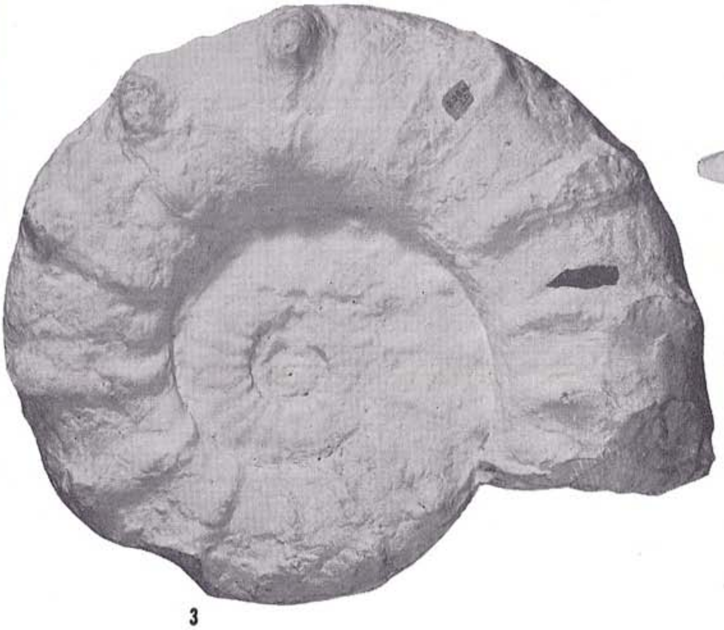
FIGS. *1–3*—*Prionocycloceras gabrielense,* n. sp.; ventral and lateral views of the holotype, UT–10808 (*see also* pl. 67, fig. 1); *1,* x1; *2, 3,* x0.25

FIG. *4*—*Prionocycloceras hazzardi,* n. sp.; ventral view of the holotype, BEG–34740 (*see also* pl. 25, fig. 2, and text figs. 13b and 14g); x0.232

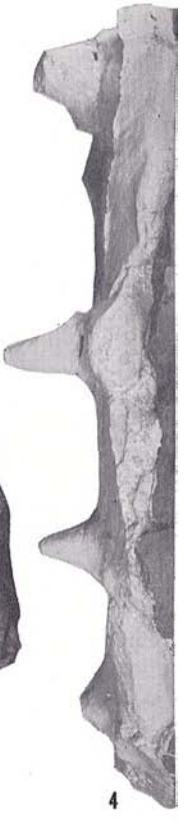
1



2



3



4

PLATE 25

FIG. *1*—*Prionocycloceras* sp. aff. *guayabanum* (Steinmann in Gerhardt); lateral view of BEG-34741 (*see also* pl. 34, fig. 5. and text fig. 15b), a large fragment; x0.5

FIG. *2*—*Prionocycloceras hazzardi*, n. sp.; lateral view of the holotype, BEG-34740 (*see also* pl. 24, fig. 4 and text figs. 13b and 14g); x0.234

FIG. *3*—*Prionocycloceras hazzardi*, n. sp.; ventral view of UT-490 (*see also* pl. 34, fig. 2, and pl. 39, fig. 3); x1


1
2
3

PLATE 26

FIGS. *1, 2*—*Prionocycloceras hazzardi,* n. sp.; ventral and lateral views of BEG–20498 (*see also* pl. 27, fig. 4, and text figs. 12f and 13d); x1

FIGS. *3, 4*—*Protexanites planatus* (Lasswitz); ventral views of UT–30504 (*see also* pl. 37, figs. 2, 3, and text fig. 25m); x0.5

FIG. *5*—*Peroniceras moureti* Grossouvre; lateral view of UT–19937 (*see also* pl. 27, fig. 1, and text fig. 13a); x1


1
3
5
4
2

TEXT FIG. 14

a—*Prionocycloceras guayabanum* (Steinmann in Gerhardt); suture of WSA–921 at a diameter of 180 mm. The sutures on this individual are asymmetric throughout the outer septate whorl; x1

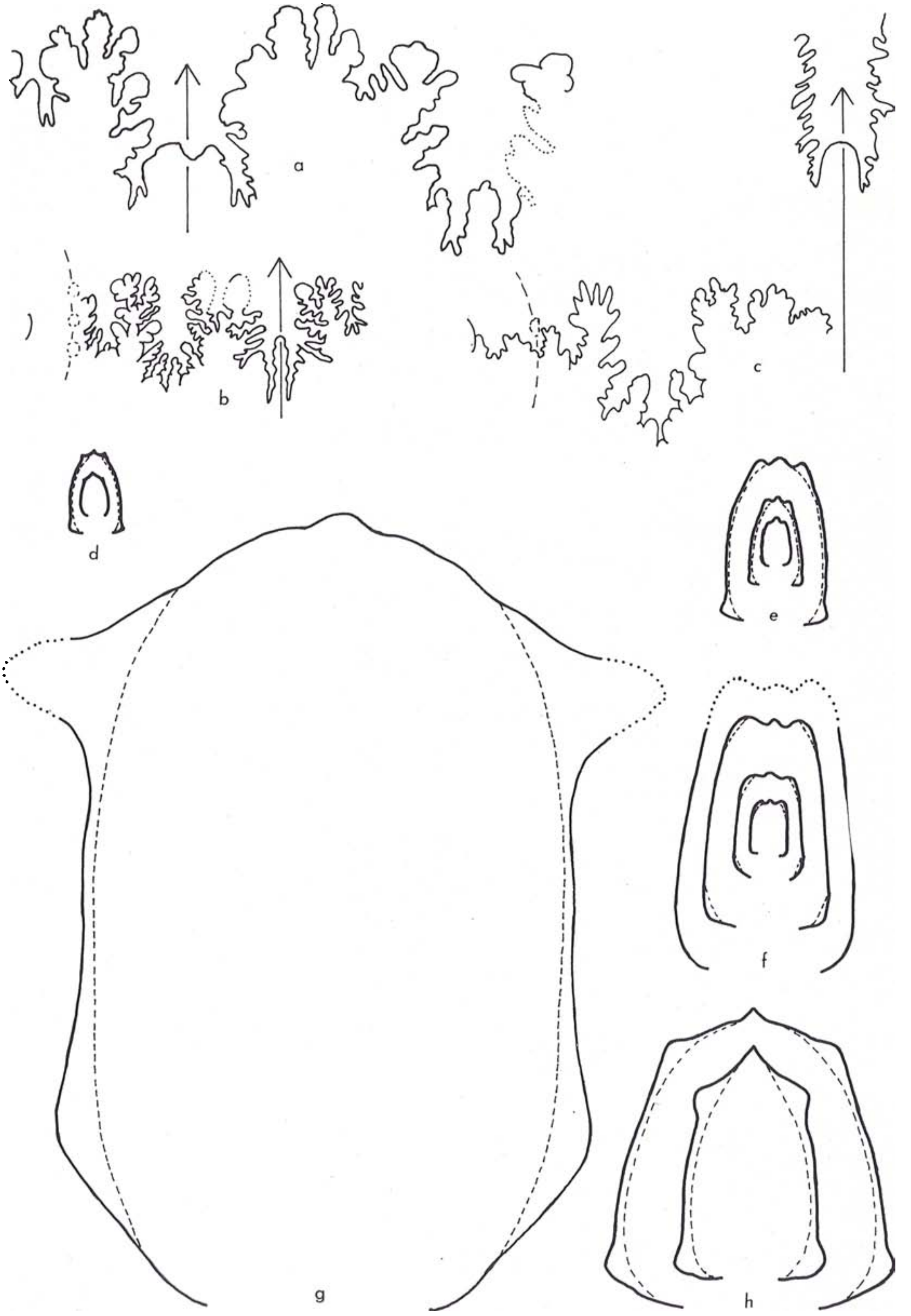
b, f—*Submortoniceras mariscalense*, n. sp.; *b*, suture of the holotype at a diameter of about 85 mm. and *f*, whorl sections of the holotype, BEG–20478, at diameters of 22.5, 40, 87, and approximately 125 mm. (*see also* pl. 59, fig. 3, and pl. 60. figs. 1, 4–6); x1

c—*Delawarella* sp.; suture of BEG–20479; x1

d, e—*Submortoniceras uddeni*, n. sp.; whorl sections of *d*, USNM–130740, a small individual from U. S. G. S. Mesozoic locality 18938 (*see also* pl. 60, figs. 2, 3, 7, 10) at diameters of 18 and 31 mm.; *e*, USNM–130739, the holotype from U. S. G. S. Mesozoic locality 18938 (*see also* pl. 59, figs. 5, 7–9) at diameters of 19.5, 31, and 65 mm.; *all*, x1

g—*Prionocycloceras hazzardi*, n. sp.; whorl section of the holotype BEG–34740 (*see also* pl. 24, fig. 4; pl. 25, fig. 2; and text fig. 13b), at a diameter of 330 mm.; x1

h—*Pseudoschloenbachia mexicana* (Renz); whorl sections of WSA–68 at diameters of 75 and 100 mm. (*see also* pl. 30, figs. 6 and 7); x1


a
b
c
d
e
f
g
h

TEXT FIG. 15

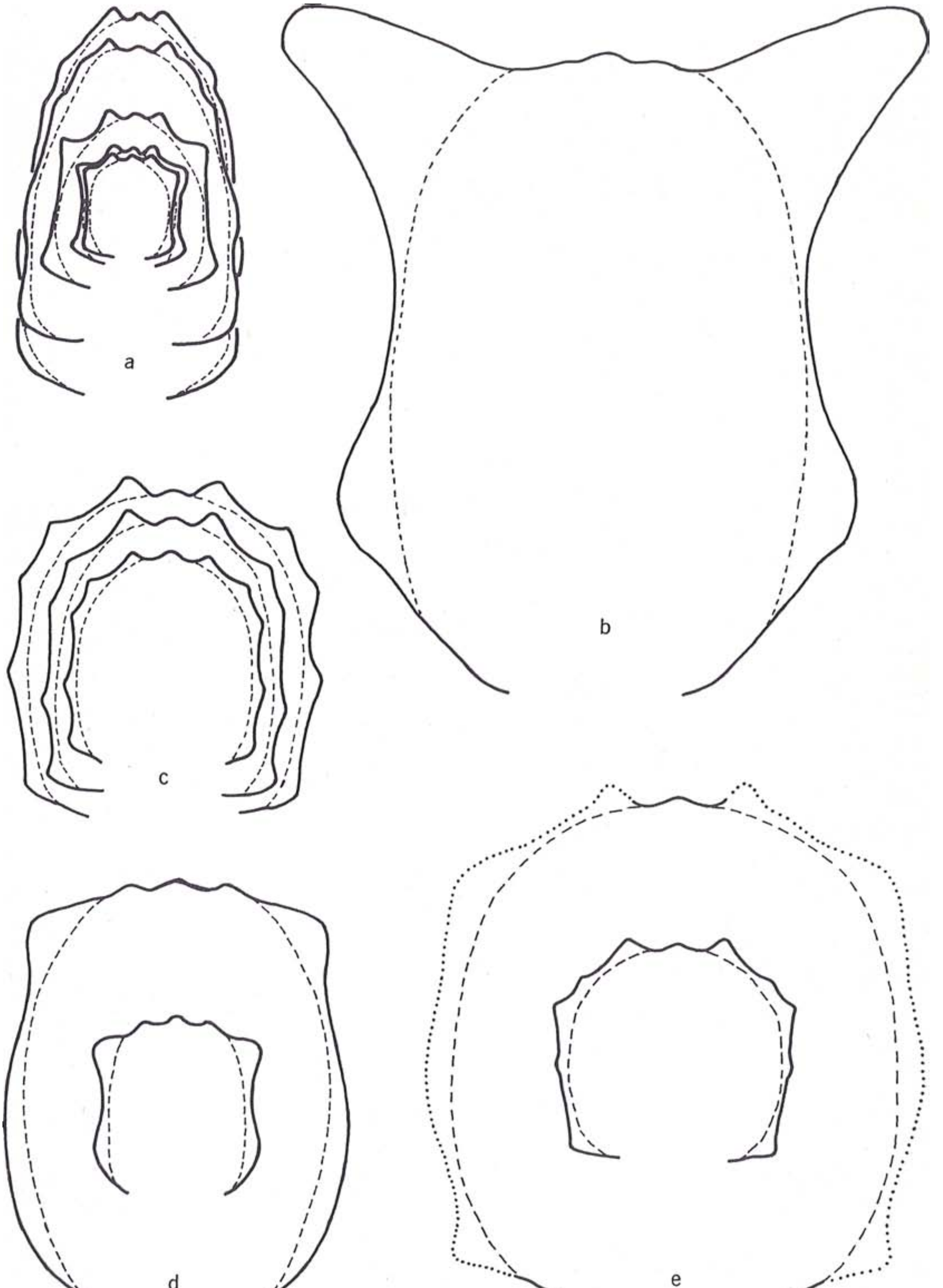
a—Menabites belli, n. sp.; whorl sections of the holotype UT–13 (*see also* pl. 70, figs. 2–4, 7) at diameters of 40, 50, 75, 125, and 175 mm.; x1

b—Prionocycloceras sp. aff. *guayabanum* (Steinmann in Gerhardt); whorl section of BEG–34741 (*see also* pl. 25, fig. 1, and pl. 34, fig. 5); x0.5

c—Bevahites bevahensis Collignon; whorl sections of individual more depressed in the adult, BEG–20364, at diameters of 75, 100, and 150 mm.; x1

d—Peroniceras westphalicum (Schlüter); whorl sections of BEG–20326, width restored, at diameters of 70 and 200 mm.; x1

e—Delawarella delawarensis (Morton); whorl sections of UT–30661 at diameters of 75 and 150 mm.; x1


a
b
c
d
e

TEXT FIG. 16

Plots for three species of *Prionocycloceras,* one species of *Protexanites,* and one species of *Paratexanites;* diameter on the ordinate against HF (fig. 16a), rib count (fig. 16b), HF/W (fig. 16c), and U (fig. 16d) on the abscissa. Asterisks represent *Prionocycloceras hazzardi,* n. sp.; crosses *P. gabrielense,* n. sp.; dots *P. guayabanum* (Gerhardt); circles *Protexanites planatus* (Lasswitz); and *x*'s *Paratexanites sellardsi,* n. sp. There seems to be little reason for differentiating the species on conch conformation. Certain trends are indicated in the rib counts (fig. 16b) that could be important if more information were available. The figure certainly emphasizes the importance of ornamentation in differentiating these species.

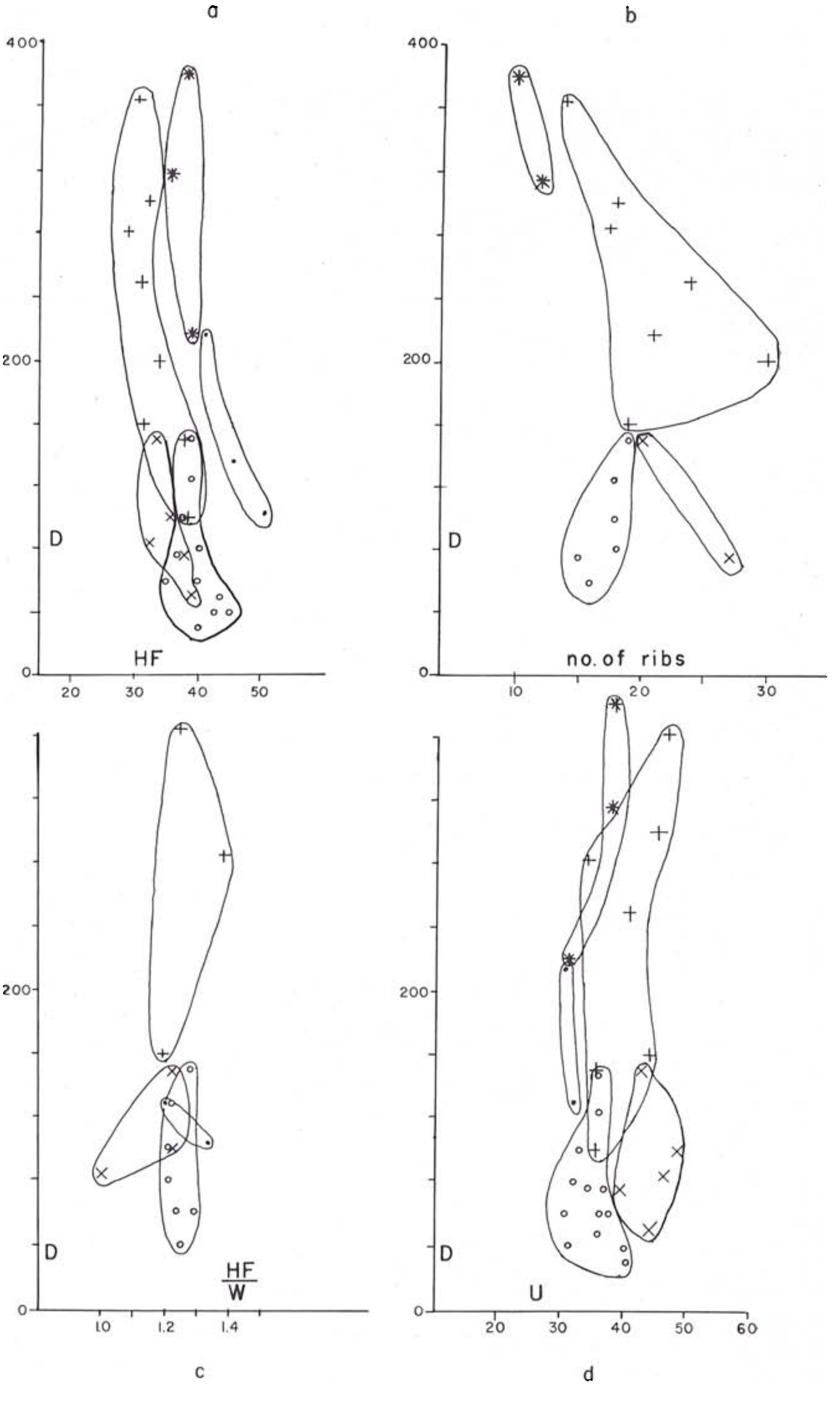

a
b
400
200
0
D
HF
20
30
40
50
no. of ribs
10
20
30
D
HF/W
1.0
1.2
1.4
U
60
c
d

PLATE 27

FIG. *1*—*Peroniceras moureti* Grossouvre; ventral view of UT–19937 (*see also* pl. 26, fig. 5, and text fig. 13a); x1

FIGS. *2, 3*—*Prionocycloceras guayabanum* (Steinmann in Gerhardt); lateral view of WSA–137 (*see also* pl. 23, figs. 5, 6, and text figs. 12a and 33d); *2*, x1; *3*, x0.5

FIG. *4*—*Prionocycloceras hazzardi*, n. sp.; lateral view of BEG–20498 (*see also* pl. 26, figs. 1 and 2, and text figs. 12f and 13d); x0.5

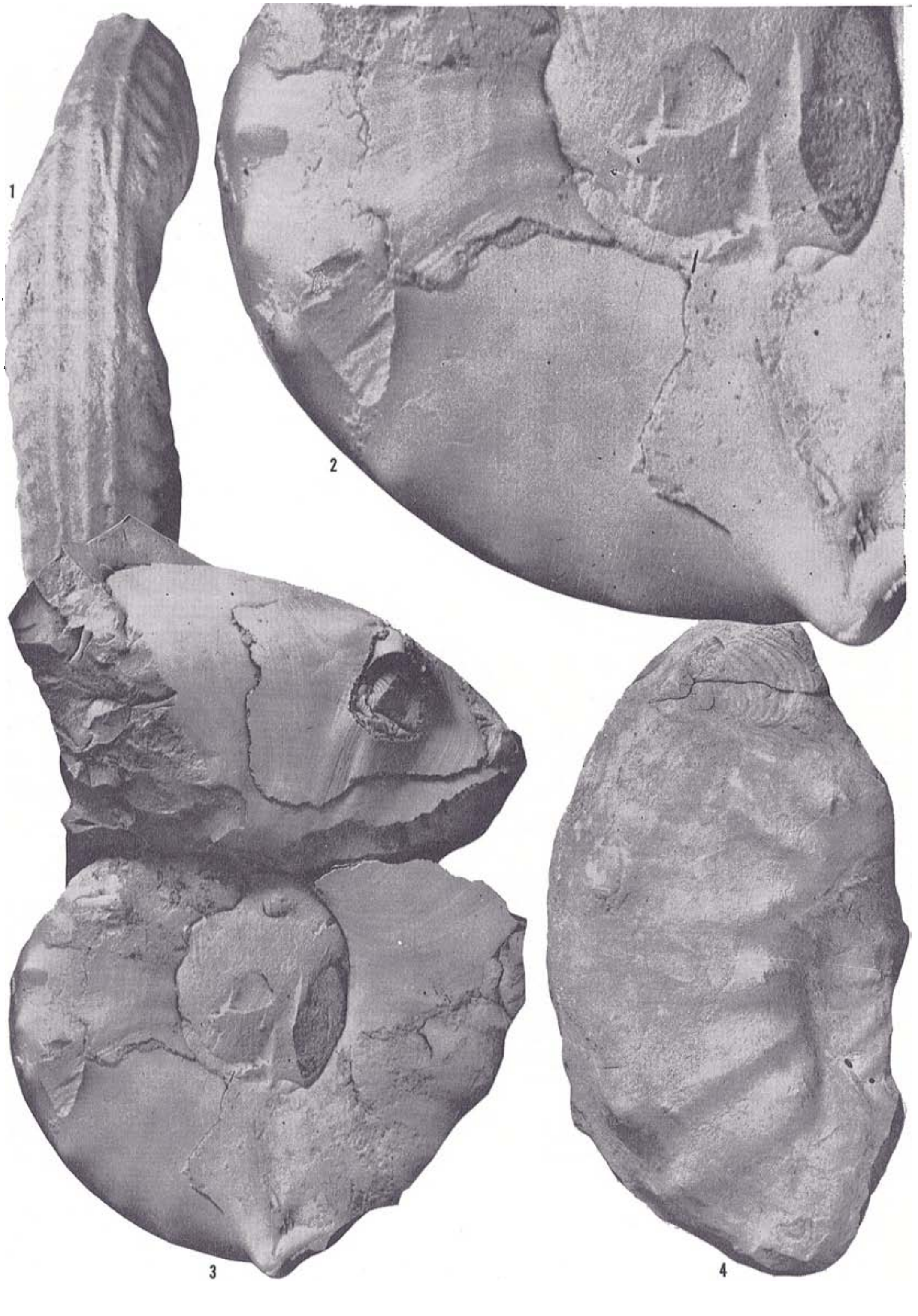

1
2
3
4

PLATE 28

FIG. *1*—*Submortoniceras tequesquitense*, n. sp.; lateral view of BEG-34743 (*see also* pl. 70, fig. 1); x1

FIGS. *2–4*—*Peroniceras westphalicum* (Schlüter); lateral and ventral views of UT-83; *2*, x0.5; *3*, *4*, x1


1
2
3
4

PLATE 29

FIGS. *1, 2*—*Peroniceras westphalicum* (Schlüter); ventral and lateral views of WSA–19; x0.5
FIGS. *3, 4*—*Pseudoschloenbachia mexicana* (Renz); lateral and ventral views of UT–7; x1
FIG. *5*—*Prionocycloceras gabrielense,* n. sp.; lateral view of UT–18109B; x0.40


1
2
3
4
5

PLATE 30

FIGS. *1–7—Pseudoschloenbachia mexıcana* (Renz); *1, 5,* lateral and ventral views of UT–22 (*see also* pl. 33, fig. 6); *2, 3,* lateral views of UT–18121 (*see also* pl. 32, fig. 4; pl. 33, fig. 2; pl. 44, fig. 1; and text fig. 28d); *4,* lateral view of WSA–247 (*see also* text fig. 13e); *6, 7,* ventral and lateral views of WSA–68 (*see also* text fig. 14h); *all,* x1

FIGS. *8, 9—Pseudoschloenbachia* sp. juv. cf. *P. mexıcana* (Renz); ventral and lateral views of WSA–90 (*see also* pl. 31, fig. 2, and pl. 33, fig. 4); x1


1
2
3
4
5
6
7
8
9

PLATE 31

FIGS. *1, 3–9*—*Pseudoschloenbachia mexicana* (Renz); *1, 5*, lateral and ventral views of UT–18124C; *3, 4,* lateral and ventral views of UT–1599; *6,* ventral view of UT–18123A (*see also* pl. 33, fig. 3); *7–9,* ventral and lateral views of BEG–20273; *all,* x1

FIG. *2*—*Pseudoschloenbachia* sp. juv. cf. *P. mexicana* (Renz); ventral view of WSA–90 (*see also* pl. 30, figs. 8, 9, and pl. 33, fig. 4); x2


1
2
3
4
5
6
7
8
9

PLATE 32

FIGS. *1–6—Pseudoschloenbachia mexicana* (Renz); *1–3,* ventral and lateral views of UT–10714; *4,* ventral view of UT-18121 (*see also* pl. 30, figs. 2, 3; pl. 33, fig. 2; pl. 44, fig. 1; and text fig. 28d); *5, 6,* lateral and ventral views of UT–18123B; *all,* x1

FIG. *7—Paratexanites sellardsi,* n. sp.; lateral view of UT–30692; x1


1
2
3
4
5
6
7

PLATE 33

FIGS. *1–3, 5–7*—*Pseudoschloenbachia mexicana* (Renz); *1, 5, 7,* ventral and lateral views of UT–19821 (*see also* text figs. 29bd); *2,* ventral view of UT–18121 (*see also* pl. 30, figs. 2, 3; pl. 32, fig. 4; pl. 44, fig. 1; and text fig. 28d); *3,* lateral view of UT–18123A (*see also* pl. 31, fig. 6); *6,* ventral view of UT–22 (*see also* pl. 30, figs. 1, 5); *all,* x1

FIG. *4*—*Pseudoschloenbachia* sp. juv. cf. *P. mexicana* (Renz); lateral view of WSA–90 (*see also* pl. 30, figs. 8, 9, and pl. 31, fig. 2); x2

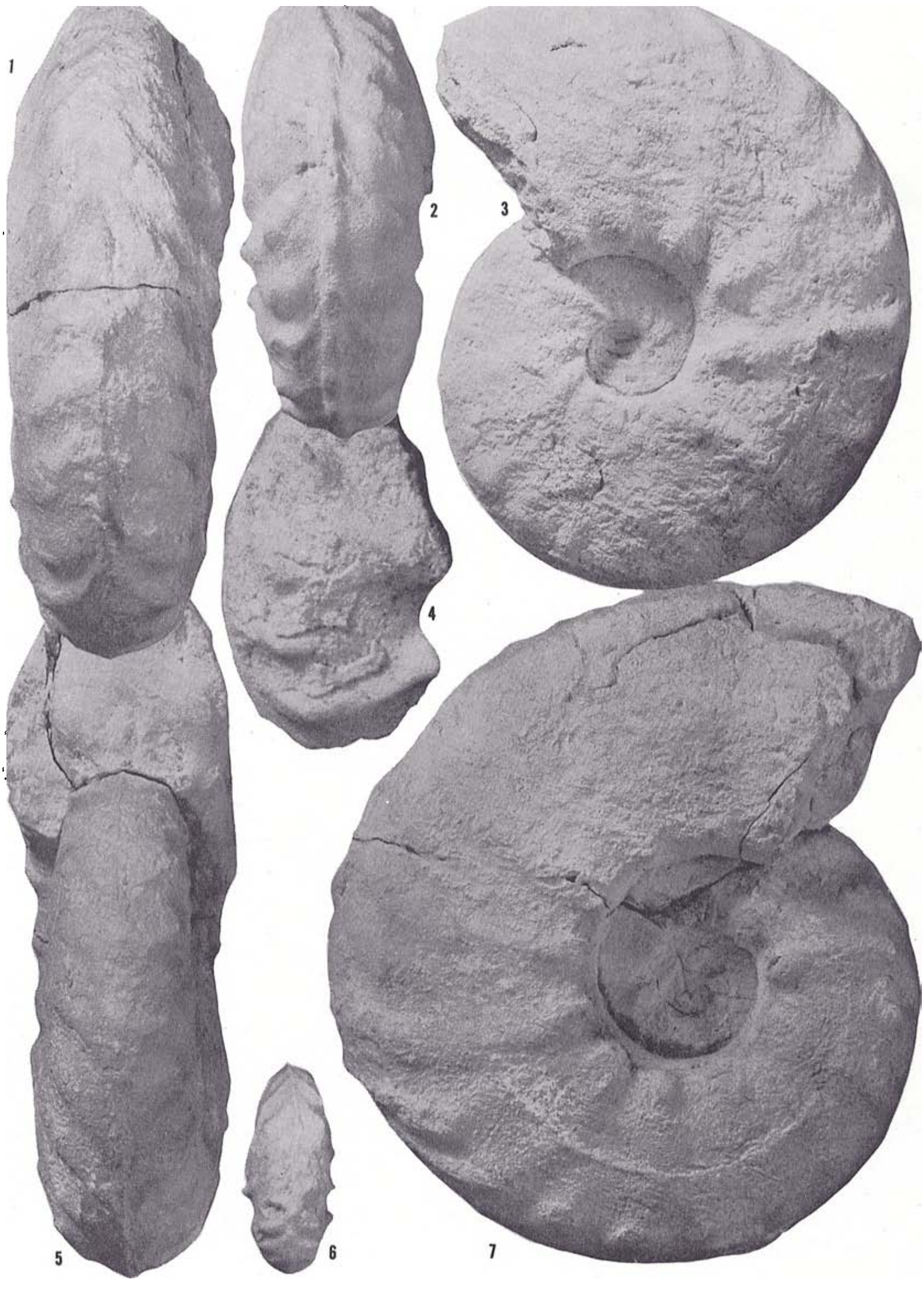

1
2
3
4
5
6
7

PLATE 34

FIG. *1—Texanites lonsdalei,* n. sp.; ventral view of UT-30474 (*see also* pl. 51, figs. 3–7; pl. 58, figs. 5, 6; and text figs. 22ad); x1

FIG. *2—Prionocycloceras hazzardi,* n. sp.; lateral view of UT-490 (*see also* pl. 25, fig. 3, and pl. 39, fig. 3); x1

FIGS. *3, 4—Peroniceras haasi,* n. sp.; ventral and lateral views of UT-10172; x1

FIG. *5—Prionocycloceras* sp. aff. *guayabanum* (Steinmann in Gerhardt); ventral view of large fragment, BEG-34741 (*see also* pl. 25, fig. 1, and text fig. 15b); x0.5

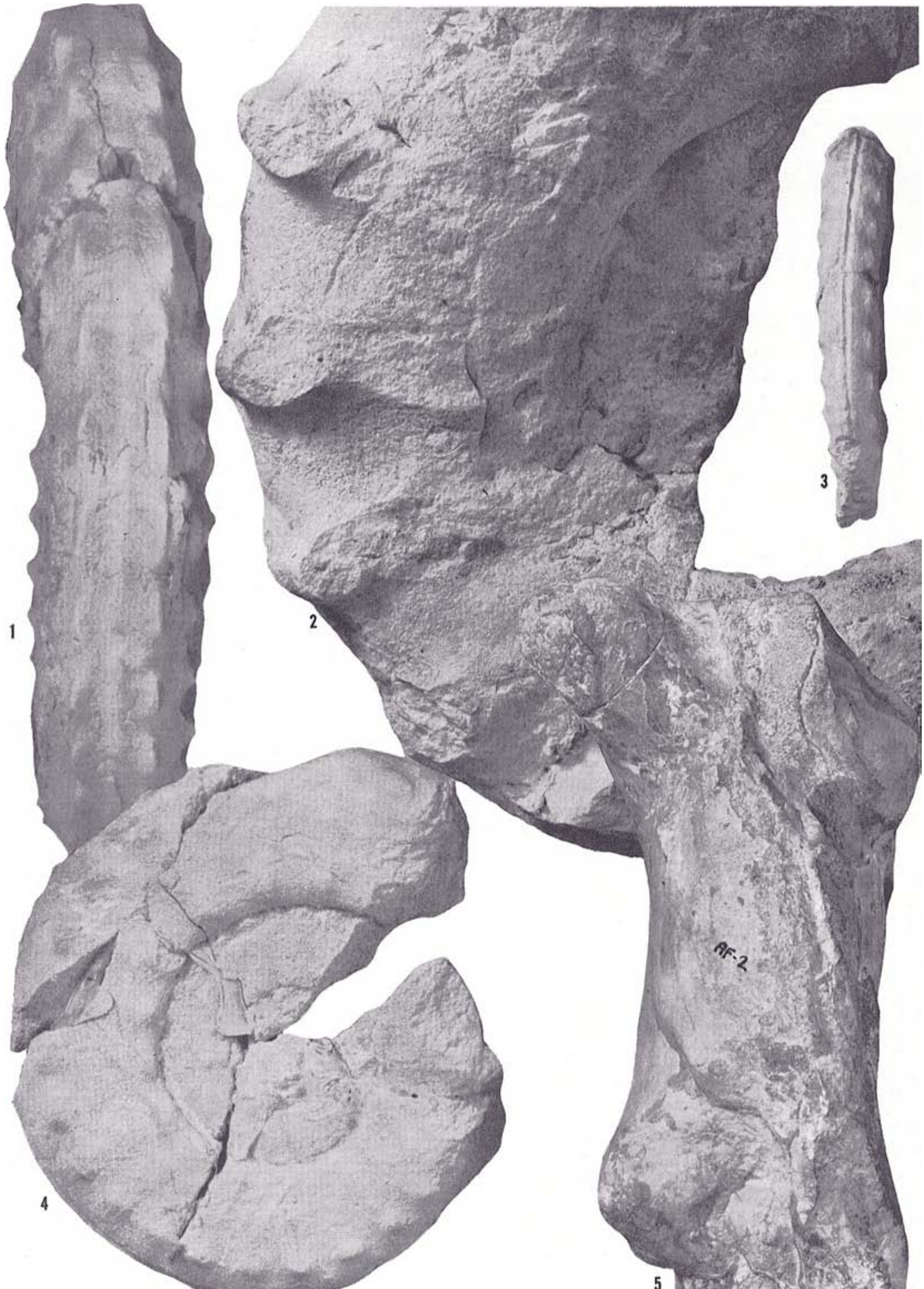

1
2
3
4
5
AF-2

PLATE 35

FIGS. *1–3—Peroniceras haasi*, n. sp.; lateral and ventral views of the holotype, UT–10175; *1*, x0.5; *2*, *3*, x1

FIG. *4—Protexanites planatus* (Lasswitz); lateral view of UT–14398B (*see also* text fig. 29c); x1

1 2 3 4

TEXT FIG. 17

Paratexanites sellardsi, n. sp.; sutures of BEG–34745 (*see also* pl. 36, figs. 3–5; pl. 37, fig. 1; pl. 39, fig. 4; and pl. 49, fig. 3), the holotype; two adjacent sutures; x1

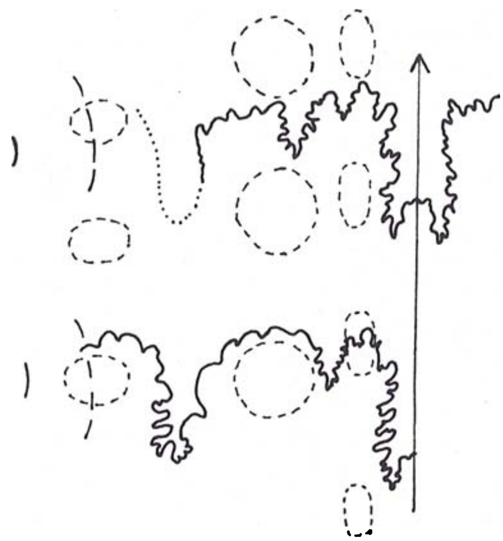


PLATE 36

FIG. *1—Protexanites planatus* (Lasswitz); ventral view of UT–14398A (*see also* pl. 37, fig. 4, and text fig. 20a); x1

FIG. *2—?Protexanites planatus* (Lasswitz); lateral view of UT–18019; x0.5

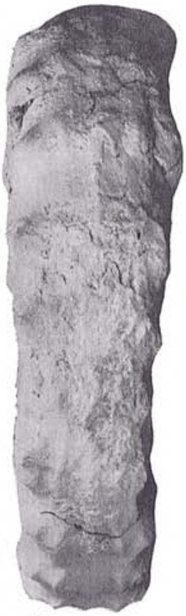
FIGS. *3–5—Paratexanites sellardsi,* n. sp.; ventral and lateral views of the holotype, BEG–34745 (*see also* pl. 37, fig. 1; pl. 39, fig. 4; pl. 49, fig. 3; and text fig. 17); *3, 4,* x1; *5,* x0.5

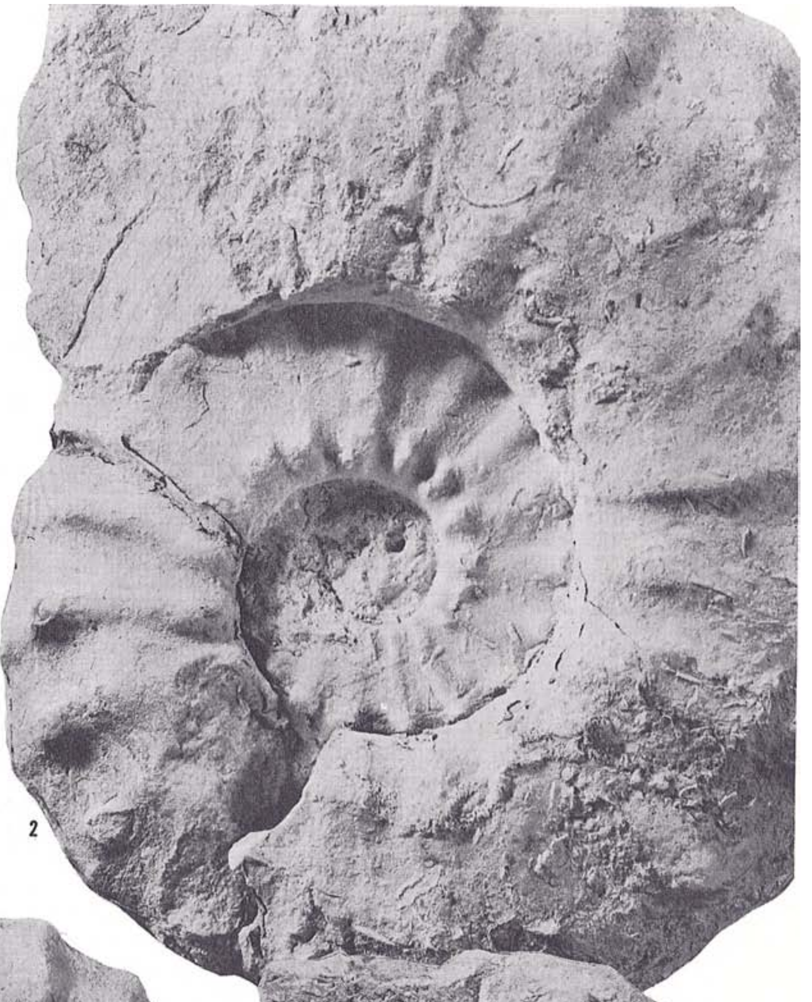

1
2
3
4
5

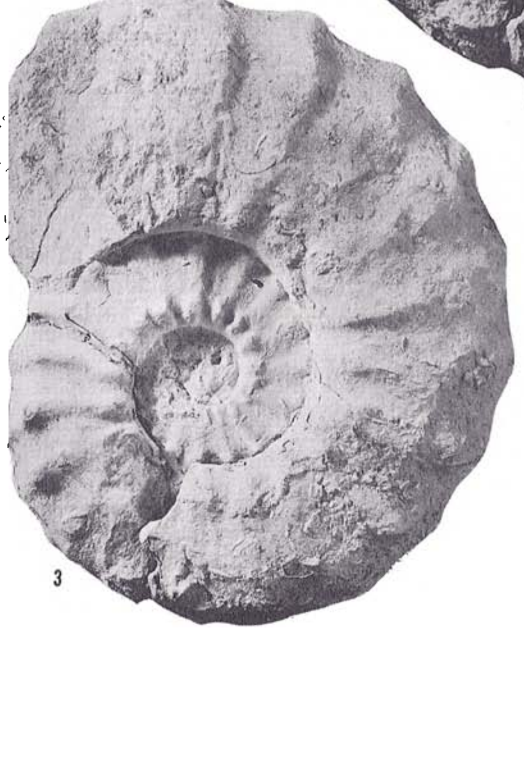
PLATE 37

FIG. *1—Paratexanites sellardsi,* n. sp.; ventral view of the holotype, BEG–34745 (*see also* pl. 36, figs. 3–5; pl. 39, fig. 4; pl. 49, fig. 3; and text fig. 17); x0.5

FIGS. *2–4—Protexanites planatus* (Lasswitz); *2, 3,* lateral views of UT–30504 (*see also* pl. 26, figs. 3, 4, and text fig. 25m); *4,* lateral view of UT–14398A (*see also* pl. 36, fig. 1, and text fig. 20a); *2, 4,* x1; *3,* x0.5


1


2


3

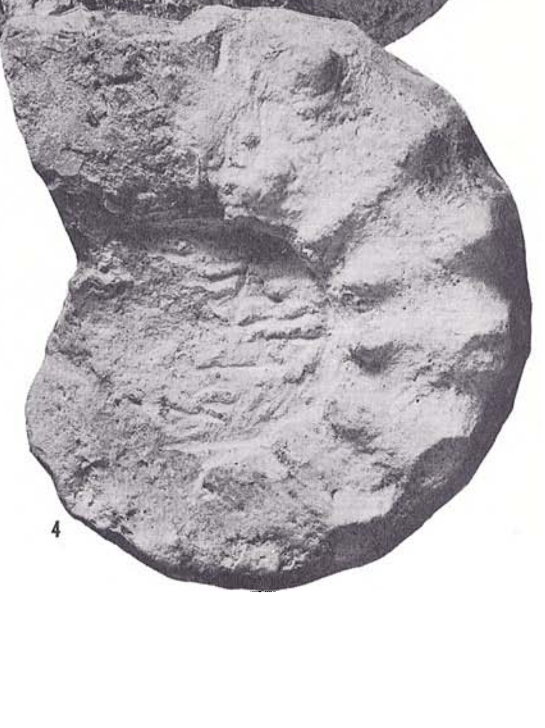

4

PLATE 38

FIGS. *1, 2*—*Texanites texanus texanus* (Römer); ventral and lateral views of a cast of the holotype deposited in the Bureau of Economic Geology (*see also* pl. 41, fig. 4, and text fig. 25d); x1

FIGS. *3, 4*—*Texanites texanus* (Römer) *gallica* Collignon; lateral and ventral views of BEG–F592; x0.5

FIG. *5*—*Texanites texanus* (Römer) *twiningi*, n. subsp.; ventral view of inner whorl of the holotype, BEG–20480 (*see also* pl. 39, fig. 1; pl. 41, figs. 2, 5; and pl. 48, fig. 4); x1


1
2
3
4
5

TEXT FIG. 18

Plots for five species of *Texanites*; diameter of conch plotted on the ordinate, against U (fig. 18a), rib count (fig. 18b), and HF (fig. 18c) on the abscissa. Crosses represent *Texanites americanus* (Lasswitz); circles *T. stangeri densicostus* (Spath), *x*'s *T. roemeri* (Yabe and Shimizu); asterisks *T. texanus gallica* Collignon; and dots *T. texanus texanus* (Römer). Although the number of observations are too few to allow for much interpretation as to the validity of the more closely related taxa, it is quite apparent from fig. 18c that whorl height increases with decrease in geologic age in these five species, and from fig. 18a that width of umbilicus decreases with decrease in geologic age. For age relationships of species see text fig. 3, p. 22.

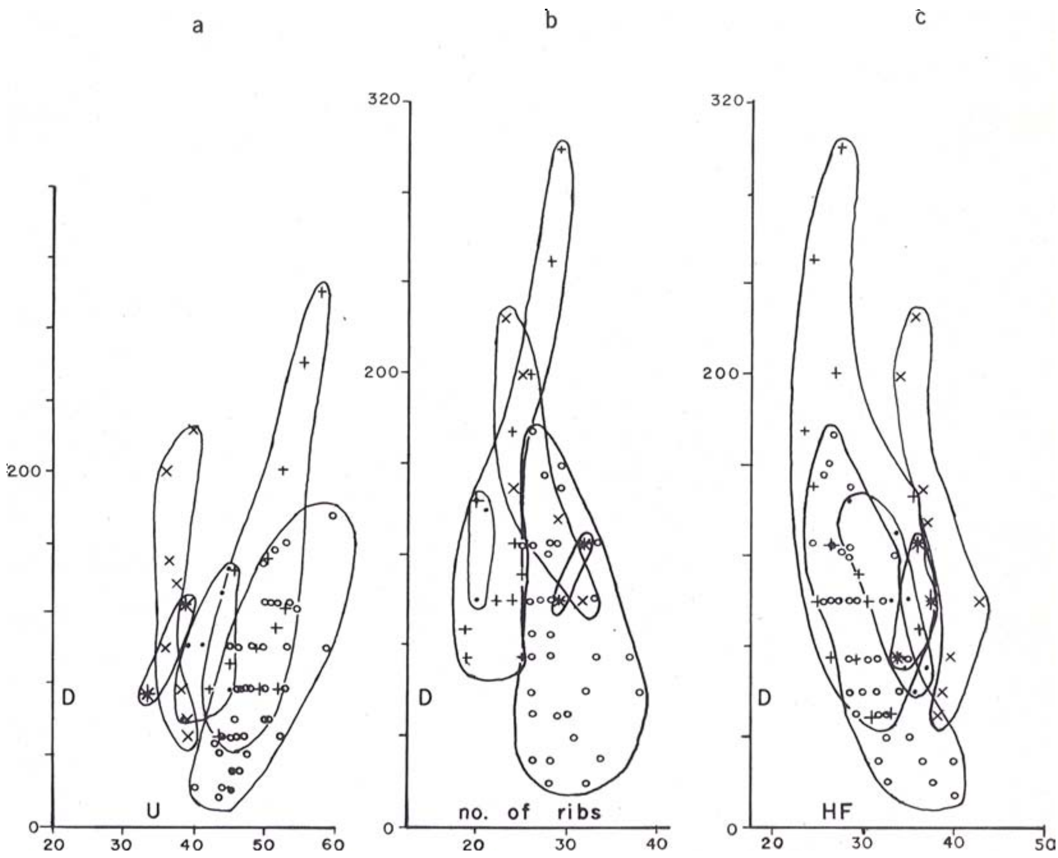

a
b
c
320
200
0
D
U
no. of ribs
HF
20
30
40
50
60

PLATE 39

FIG. *1—Texanites texanus* (Römer) *twiningi*, n. subsp.; lateral view of outer whorl of the holotype, BEG–20480 (*see also* pl. 38, fig. 5; pl. 41, figs. 2, 5; pl. 48, fig. 4); x1

FIG. *2—Reginaites durhami*, n. sp.; ventral view of the holotype, WSA–221 (*see also* pl. 49, figs. 1, 2, 4, and text figs. 22bc); x1

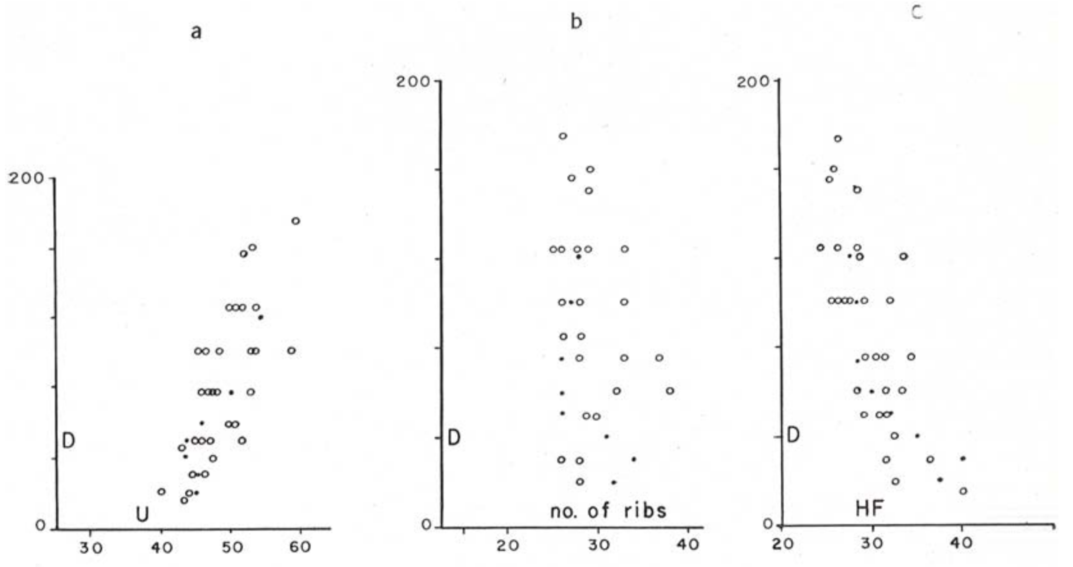
FIG. *3—Prionocycloceras hazzardi*, n. sp.; lateral view of UT–490 (*see also* pl. 25, fig. 3, and pl. 34, fig. 2); x0.5

FIG. *4—Paratexanites sellardsi*, n. sp.; ventral view of the holotype, BEG–34745 (*see also* pl. 36, figs. 3–5; pl. 37, fig. 1; pl. 49, fig. 3, and text fig. 17), x1


1
2
3
4

TEXT FIG. 19

Plots for *Texanites stangeri densicostus* (Spath); diameter on the ordinate against U (fig. 19a), rib count (fig. 19b), and HF (fig. 19c), on the abscissa. Circles represent Texas species; dots represent measurements taken from Spath's (1921) illustration of the holotype. The agreement between the South African holotype and the Texas specimens is very good.


a
b
c
200
0
D
U
30
40
50
60
200
0
D
no. of ribs
20
30
40
200
0
D
HF
20
30
40

TEXT FIG. 20

a—*Protexanites planatus* (Lasswitz); whorl section of UT–14398A (*see also* pl. 37, fig. 4, and pl. 36, fig. 1), at a diameter of 60 mm., x1

b—*Submortoniceras candelariae*, n. sp.; suture of the holotype, UT–10905 (*see also* pl. 56, figs. 3, 4, and text figs. 28a and 29e), at a diameter of 230 mm., x1

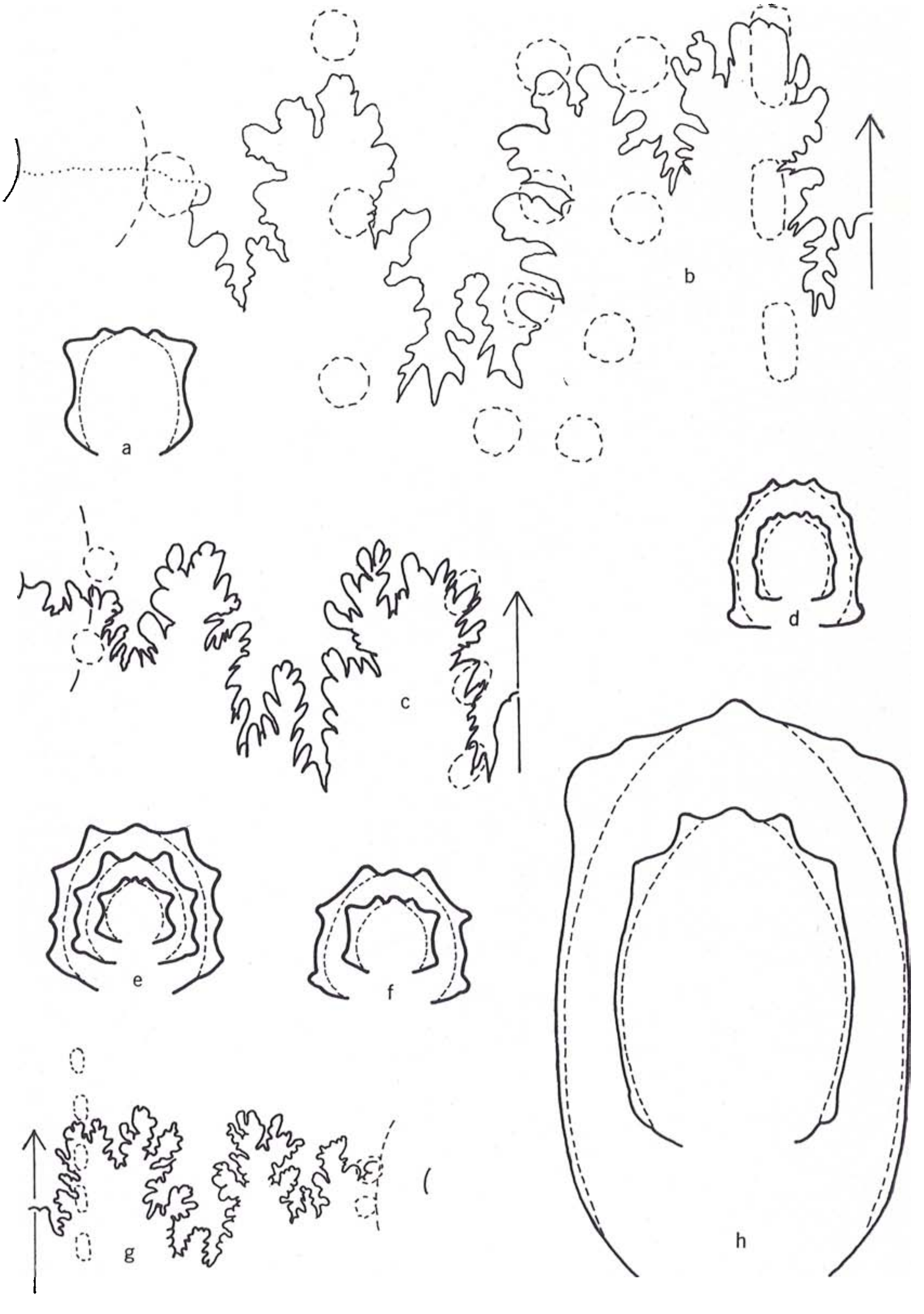
c—*Delawarella sabinalensis*, n. sp.; suture from the holotype, WSA–13 (*see also* pl. 63, figs. 1, 3, 4, and text figs. 21e and 26c) at a diameter of 300 mm., x0.5

d—*Delawarella delawarensis* (Morton); whorl sections of BEG–20322 at diameters of 30 and 50 mm., x1

e, f—*Menabites walnutensis*, n. sp.; whorl section of the holotype, UT–18 (*see also* pl. 58, figs. 1, 4, and text fig. 26k); *e*, at diameters of 20, 52, and 73 mm.; *f*, at diameters of 40 and 60 mm.; *both* x1

g—*Submortoniceras sancarlosense*, n. sp.; suture from the holotype, WSA–96 (*see also* pl. 55, figs. 1–4, pl. 62, fig. 3, and text fig. 27d) at a diameter of 105 mm., x1

h—*Prionocycloceras hazzardi*, n. sp.; whorl section of WSA–876, at diameters of 160 and 218 mm., x1


a
b
c
d
e
f
g
h

TEXT FIG. 21

a—*Protexanites shoshonensis* (Meek); USNM–73270; whorl sections at diameters of 71 and 138 mm. This specimen is from the Cody shale and is included here for comparison with *Protexanites planatus* (Lasswitz) and *Paratexanites sellardsi*, n. sp. It was illustrated by Reeside (1927) on pl. 7, figs. 1 and 2; x1

b, f—*Defordiceras hazzardi*, n. gen., n. sp.; *b*, whorl section of the holotype at a diameter of 130 mm., and *f*, suture of the holotype at a diameter of 130 mm.; BEG–20285 (*see also* pl. 69, figs. 3–5); x1

c—*Prionocycloceras gabrielense*, n. sp.; whorl sections, restored, of UT–18109, at diameters of 160 and 285 mm., x1

d—*Bevahites bevahensis* Collignon; suture of UT–23 at a diameter of 40 mm., x1

e—*Delawarella sabinalensis*, n. sp.; suture from the holotype, WSA–13 (*see also* pl. 63, figs. 1, 3, 4, and text figs. 20c and 26c), at a diameter of 170 mm., x1

g—*Texanites texanus texanus* (Römer); suture from BEG–34744 (*see also* pl. 40, fig. 3, and text fig. 22e), x1


a
b
c
d
e
f
g

TEXT FIG. 22

a, d—Texanites lonsdalei, n. sp.; *a*, suture at a diameter of 230 mm.; *d*, whorl sections at diameters of 125, 175, 250, and 370 mm.; *both*, UT–30474 (*see also* pl. 34, fig. 1; pl. 51, figs. 3–7; and pl. 58, figs. 5, 6); *both*, x1

b, c—Reginaites durhami, n. sp.; whorl sections of WSA–221 (*see also* pl. 39, fig. 2, and pl. 49, figs. 1, 2, 4); *b*, at diameters of 150 and 250 mm.; *c*, at diameters of 100 and 190 mm.; *all*, x1

e—Texanites texanus texanus (Römer); whorl section of BEG–34744 (*see also* pl. 40, fig. 3, and text fig. 21g). This section is restored, and the thickness is probably too great, but the thickness is really not known in this species because all known specimens are crushed; x1

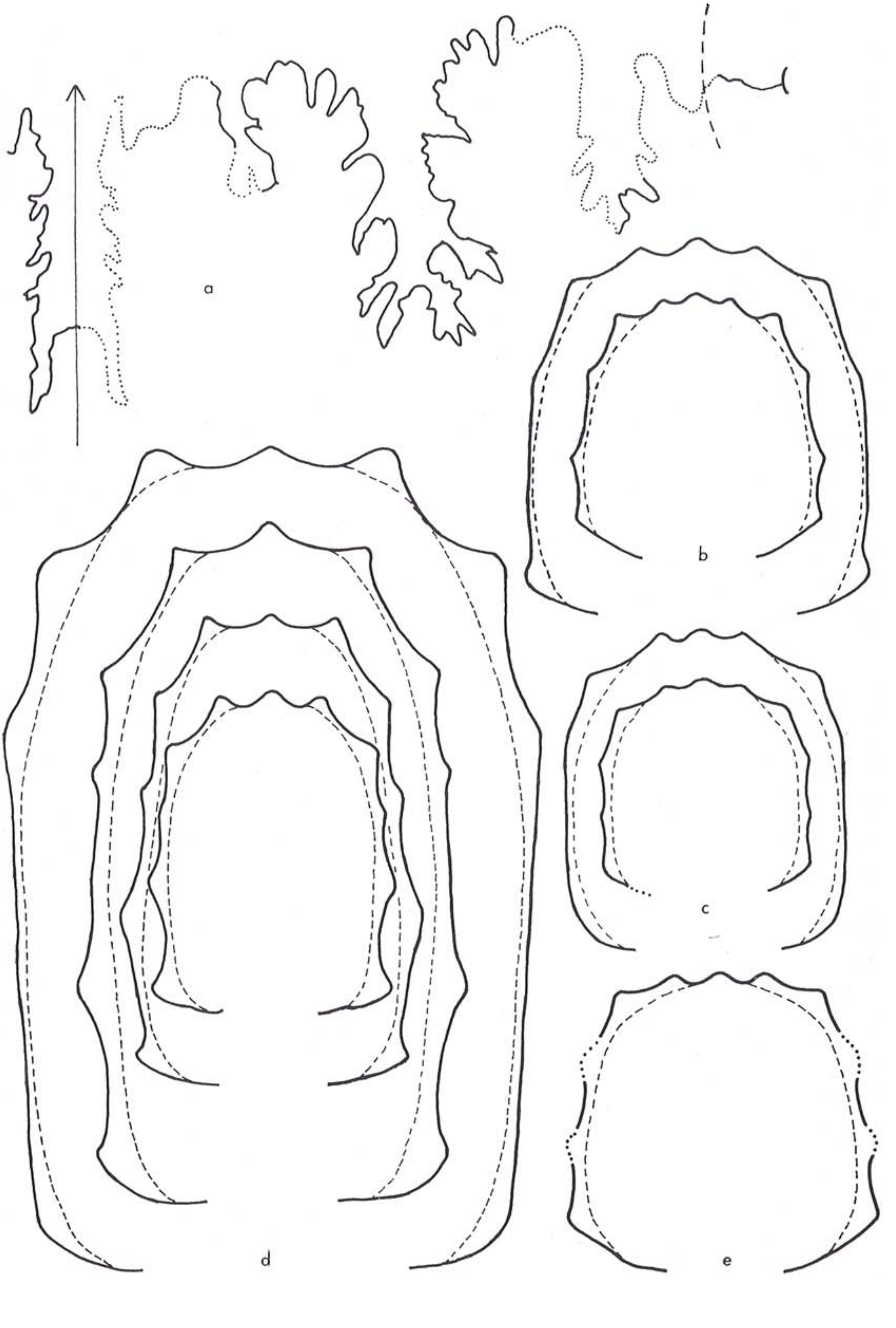

a
b
c
d
e

PLATE 40

FIGS. *1–3*—*Texanites texanus texanus* (Römer); *1,* lateral view of UT–486; *2,* ventral view of BEG–20493; *3,* lateral view of BEG–34744 (*see also* text figs. 21g and 22e); *all,* x1

1

2

3

PLATE 41

FIGS. *1, 3*—*Texanites americanus* (Lasswitz); ventral views of UT-19872 (*see also* pl. 48, figs. 1, 3); x1

FIGS. *2, 5*—*Texanites texanus* (Romer) *twiningi*, n. subsp.; lateral and ventral views of the outer whorl of the holotype, BEG-20480 (*see also* pl. 38, fig. 5; pl. 39, fig. 1; and pl. 48, fig. 4); x1

FIG. *4*—*Texanites texanus texanus* (Römer); ventral view of cast of the holotype, deposited in the Bureau of Economic Geology (*see also* pl. 38, fig. 1, 2, and text fig. 25d); x1

PLATE 42

FIGS. *1, 2*—*Submortoniceras tequesquitense,* n. sp.; ventral views of the holotype, BEG–34742 (*see also* pl. 52, figs. 1, 2, 4, and text fig. 28b); x1

FIGS. *3, 4*—*Texanites stangeri* (Baily) *densicostus* (Spath); lateral views of BEG–17503 (*see also* pl. 71, fig. 2); *3*, x1; *4*, x0.5


1
2
3
4

PLATE 43

FIG. *1*—*Texanites roemeri* (Yabe and Shimizu); lateral view of WSA–71; x1

FIGS. *2–4*—*Texanites stangeri* (Baily) *densicostus* (Spath); *2, 4,* ventral and lateral views of WSA–201 (*see also* text fig. 34c); *3,* lateral view of WSA–49 (*see also* pl. 48, fig. 5; pl 71, figs. 1, 4; and text fig. 25g); *2, 4,* x1; *3,* x0.5

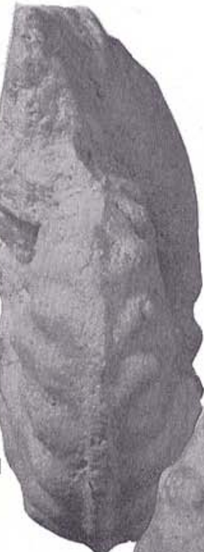

1
2
3
4

PLATE 44

FIG. *1*—*Pseudoschloenbachia mexicana* (Renz); ventral view of UT-18121 (*see also* pl. 30, figs. 2, 3; pl. 32, fig. 4; pl. 33, fig. 2; and text fig. 28d); x1

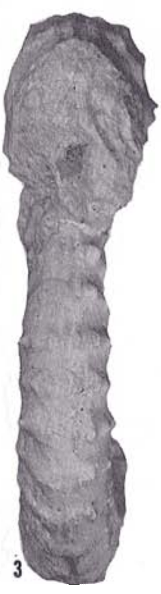
FIGS. *2, 3*—*Texanites americanus* (Lasswitz); lateral and ventral views of neotype, UT-563 (*see also* pl. 57, fig. 5, and text fig. 24c); *2*, x0.5; *3*, x0.25

FIGS. *4, 5*—*Submortoniceras tequesquitense*, n. sp.; lateral and ventral views of UT-1367; x1

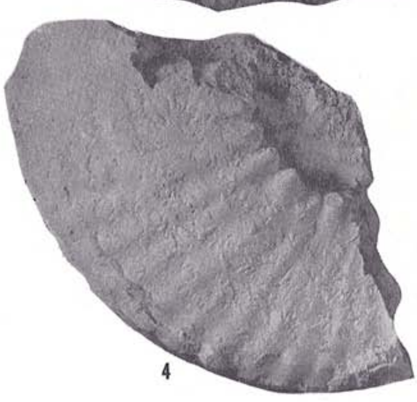


1

2



3



4

5

PLATE 45

FIGS. *1–3*—*Texanites stangeri* (Baily); ventral and lateral views of WSA–92 (*see also* text fig. 25p); from the Umkwelane River; *1, 3,* x1; *2,* x0.5


1
2
3

PLATE 46

FIGS. *1–4—Texanites shiloensis*, n. sp.; *1*, lateral view of the holotype, UT–1986 (*see also* pl. 70, fig. 8); *2–4*, ventral and lateral views of UT–1696 (*see also* pl. 70, fig. 5, and text fig. 24d); *1*, x0.25; *2, 3*, x0.5; *4*, x1


1
2
3
4

PLATE 47

FIGS. *1–4*—*Bevahites costatus* Collignon *coahuilaensis*, n. subsp.; ventral views and lateral views of BEG–20288 (*see also* pl. 71, fig. 5, and text fig. 34b); *1–3*, x1; *4*, x0.5

FIGS. *5, 6*—*Texanites stangeri* (Baily) *densicostus* (Spath); lateral and ventral views of UT–92; x1


1
2
3
4
5
6

PLATE 48

FIGS. *1, 3*—*Texanites americanus* (Lasswitz); lateral and ventral views of UT–19872 (*see also* pl. 41, figs. 1, 3); *1*, x1; *3*, x0.5

FIGS. *2, 5, 6*—*Texanites stangeri* (Baily) *densicostus* (Spath); *2, 6*, ventral views of BEG–20282 (*see also* pl. 71, fig. 3, and text fig. 25c); *5*, ventral view of WSA–49 (*see also* pl. 43, fig. 3; pl. 71, figs. 1, 4; and text fig. 25g); *all*, x1

FIG. *4*—*Texanites texanus* (Romer) *twiningi*, n. subsp.; lateral view of inner whorl of the holotype, BEG–20480 (*see also* pl. 38, fig. 5; pl. 39, fig. 1; and pl. 41, figs. 2, 5); x1


1
2
3
4
5
6

PLATE 49

FIGS. *1, 2, 4*—*Reginaites durhami,* n. sp.; lateral and ventral views of the holotype, WSA–221 (*see also* pl. 39, fig. 2, and text figs. 22bc); *1*, x0.5; *2*, *4*, x1

FIG. *3*—*Paratexanites sellardsi,* n. sp.; ventral view of the holotype, BEG–34745 (*see also* pl. 36, figs. 3–5; pl. 37, fig. 1; pl. 39, fig. 4, and text fig. 17); x0.5


1
2
3
4

PLATE 50

FIGS. *1–5*—*Texanites* sp. indet., monstrosity; ventral and lateral views of a small monstrosity, UT–108, with 4 rows of tubercles on the left side and 5 rows of tubercles on the right side; *1, 3,* x2; *2, 4, 5,* x1

FIGS. *6, 7*—*Menabites densinodosus* (Renz); lateral views of UT–30477 (*see also* text fig. 27a); *6,* x0.25; *7,* x0.73


1
2
6
3
4
5
7

PLATE 51

FIGS. *1, 2*—*Submortoniceras tequesquitense,* n. sp.; lateral view of inner whorl and ventral view of outer whorl of UT-1600 (*see also* pl. 52, fig. 3, and text fig. 12b), x1

FIGS. *3–7*—*Texanites lonsdalei,* n. sp.; ventral and lateral views of the holotype, UT-30474 (*see also* pl. 34, fig. 1; pl. 58, figs. 5, 6; and text figs. 22ad); *3, 5, 7,* x0.5; *4,* x0.25; *6,* x1


1
2
3
4
5
6
7

PLATE 52

FIGS. *1–4—Submortoniceras tequesquitense*, n. sp.; *1, 2, 4,* lateral and ventral views of the holotype, BEG–34742 (*see also* pl. 42, figs. 1, 2, and text fig. 28b); *3,* lateral view of UT–1600 (*see also* pl. 51, figs. 1, 2, and text fig. 12b); *1, 3,* x2; *2, 4,* x1

1

2

3

4

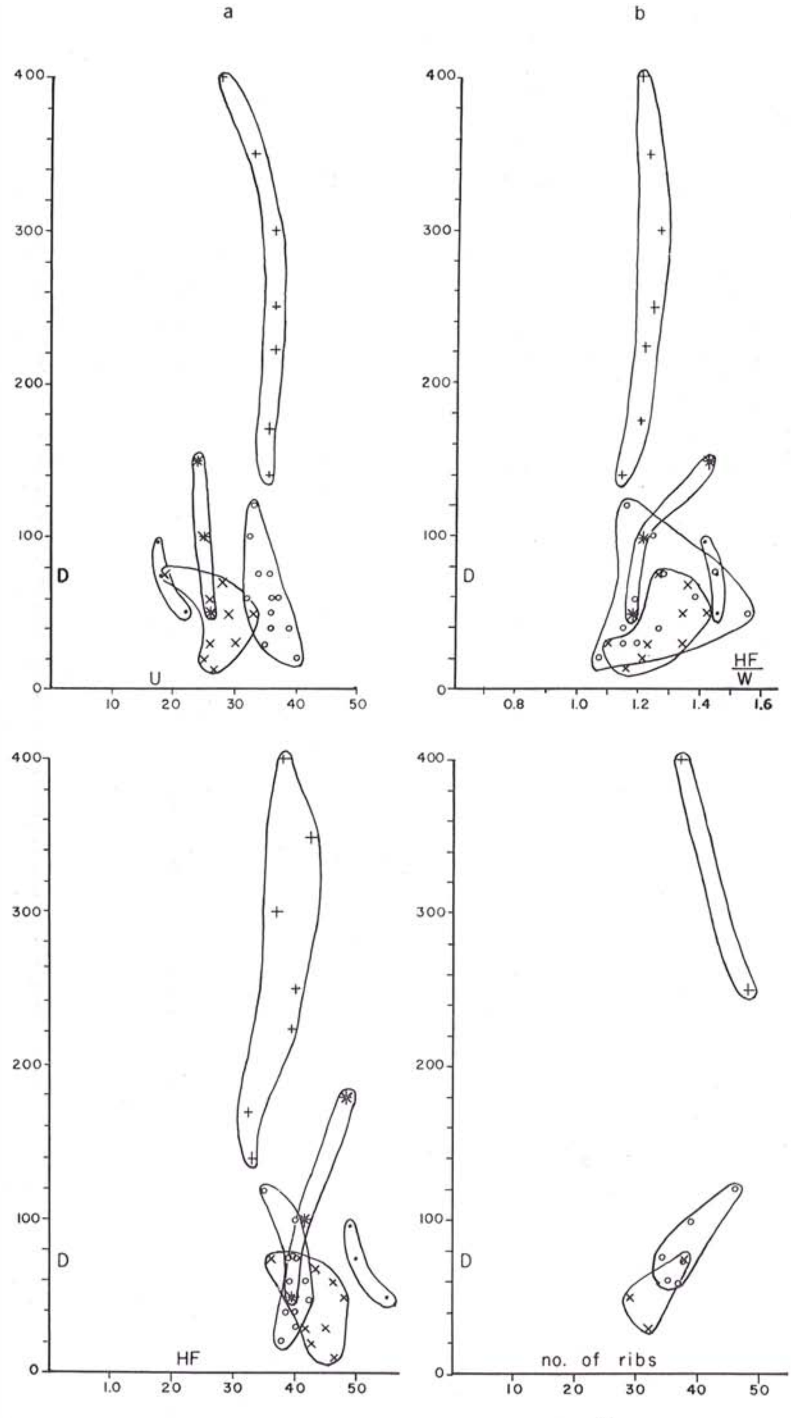
PLATE 53

FIGS. *1–7*—*Bevahites bevahensis* Collignon; *1, 2, 7,* ventral and lateral views of UT–30511 (*see also* text fig. 27b); *3–6,* ventral and lateral views of BEG–20281; *1, 7,* x0.5; *2–6,* x1


1
2
3
4
5
6
7

TEXT FIG. 23

Plots for five species of *Submortoniceras;* diameter of conch plotted on the ordinate against U (fig. 23a), HF/W (fig. 23b), HF (fig. 23c), and rib count (fig. 23d), on the abscissa. Crosses represent *Submortoniceras candelariae,* n. sp.; asterisks *S. sancarlosense,* n. sp.; circles *S. tequesquitense,* n. sp.; *x*'s *S. vanuxemi* (Morton); and dots *S. vandaliaense,* n. sp. Although the number of observations is limited, there is certainly an increase in height of whorl and a decrease in width of umbilicus from *S. tequesquitense* through *S. vanuxemi* to *S. vandaliaense.*


a
b
400
300
200
100
0
D
U
10
20
30
40
50
0.8
1.0
1.2
1.4
1.6
HF
W
HF
no. of ribs
c
d

TEXT FIG. 24

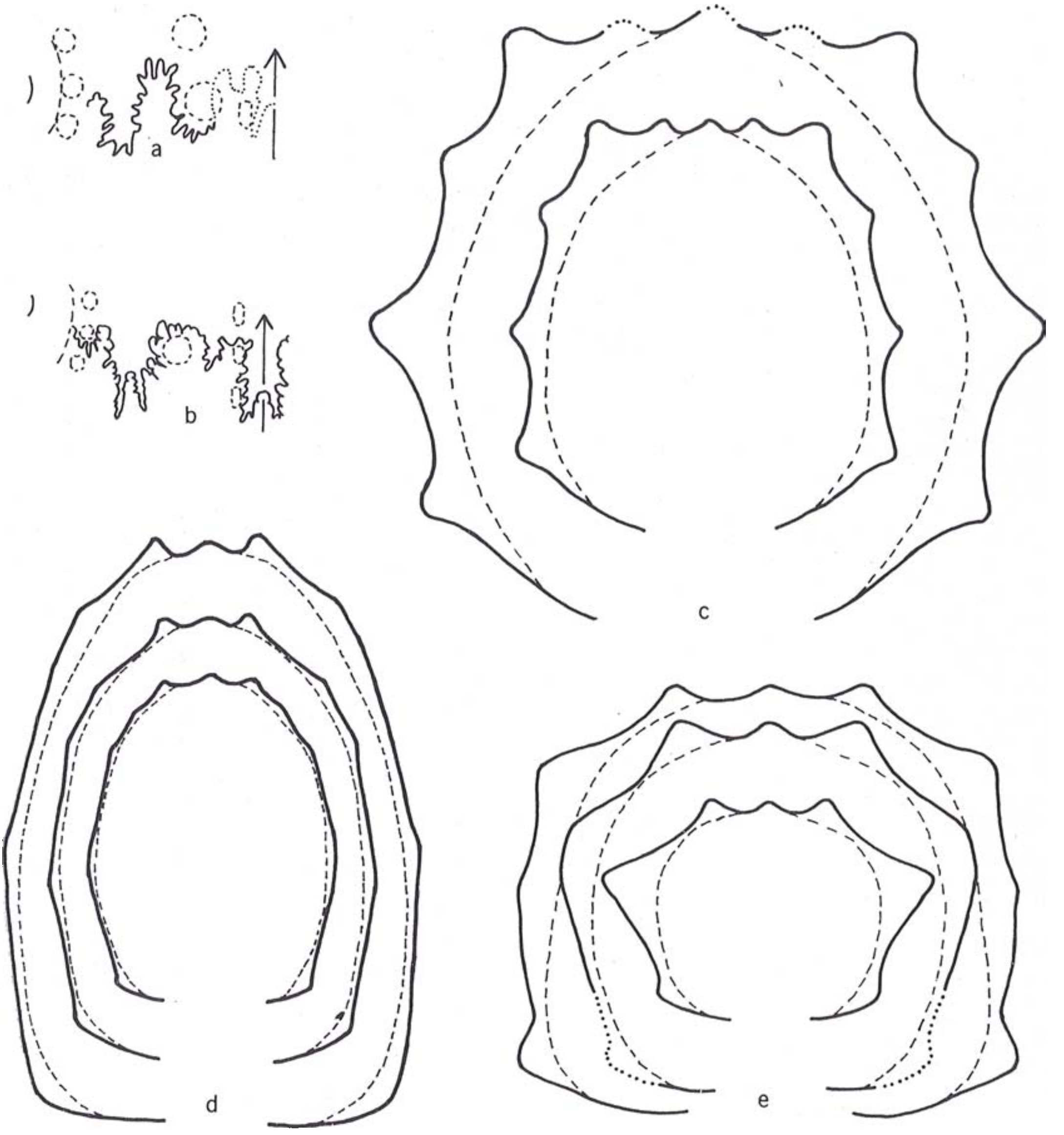
a—*Delawarella campaniensis* (Grossouvre); suture of BEG–34746 (*see also* pl. 64, figs. 2, 6; pl. 67, fig. 2; and text fig. 25a), at a diameter of 70 mm.; x1

b—*Australiella pattoni,* n. sp.; suture of UT–18122B (*see also* pl. 66, figs. 1, 2, and text fig. 33c); x1

c—*Texanites americanus* (Lasswitz); whorl sections of the neotype, UT–563 (*see also* pl. 44, figs. 2, 3, and pl. 57, fig. 5), at diameters of 200 and 300 mm.; x1

d—*Texanites shiloensis,* n. sp.; whorl sections of UT–1696 (*see also* pl. 46, figs. 2–4 and pl. 70, fig. 5) at diameters of 100, 150, and 200 mm.; x1

e—*Delawarella danei,* n. sp.; whorl sections of UT–30628 (*see also* pl. 64, fig. 1; pl. 65, fig. 2; and pl. 66, fig. 3) at diameters of 75, 100, and 150 mm.; x1


a
b
c
d
e

TEXT FIG. 25

a—Delawarella campaniensis (Grossouvre); whorl sections of BEG–34746 (*see also* pl. 64, figs. 2, 6; pl. 67, fig. 2; and text fig. 24a); at diameters of 75 and 125 mm.; x1

b—Delawarella delawarensis (Morton); badly eroded suture of BEG–34748 (*see also* text fig. 26g); x1

c, e, g, h—Texanites stangeri (Baily) *densicostus* (Spath); *c,* suture fragment of UT–594; *e,* whorl sections of BEG–20282 (*see also* pl. 48, figs. 2, 6, and pl. 71, fig. 3) at diameters of 50 and 100 mm.; *g,* whorl sections of WSA–49 (*see also* pl. 43, fig. 3; pl. 48, fig. 5; and pl. 71, figs. 1, 4) at diameters of 50 and 125 mm.; *h,* whorl sections of UT–30502 at diameters of 100 and 156 mm.; *all,* x1

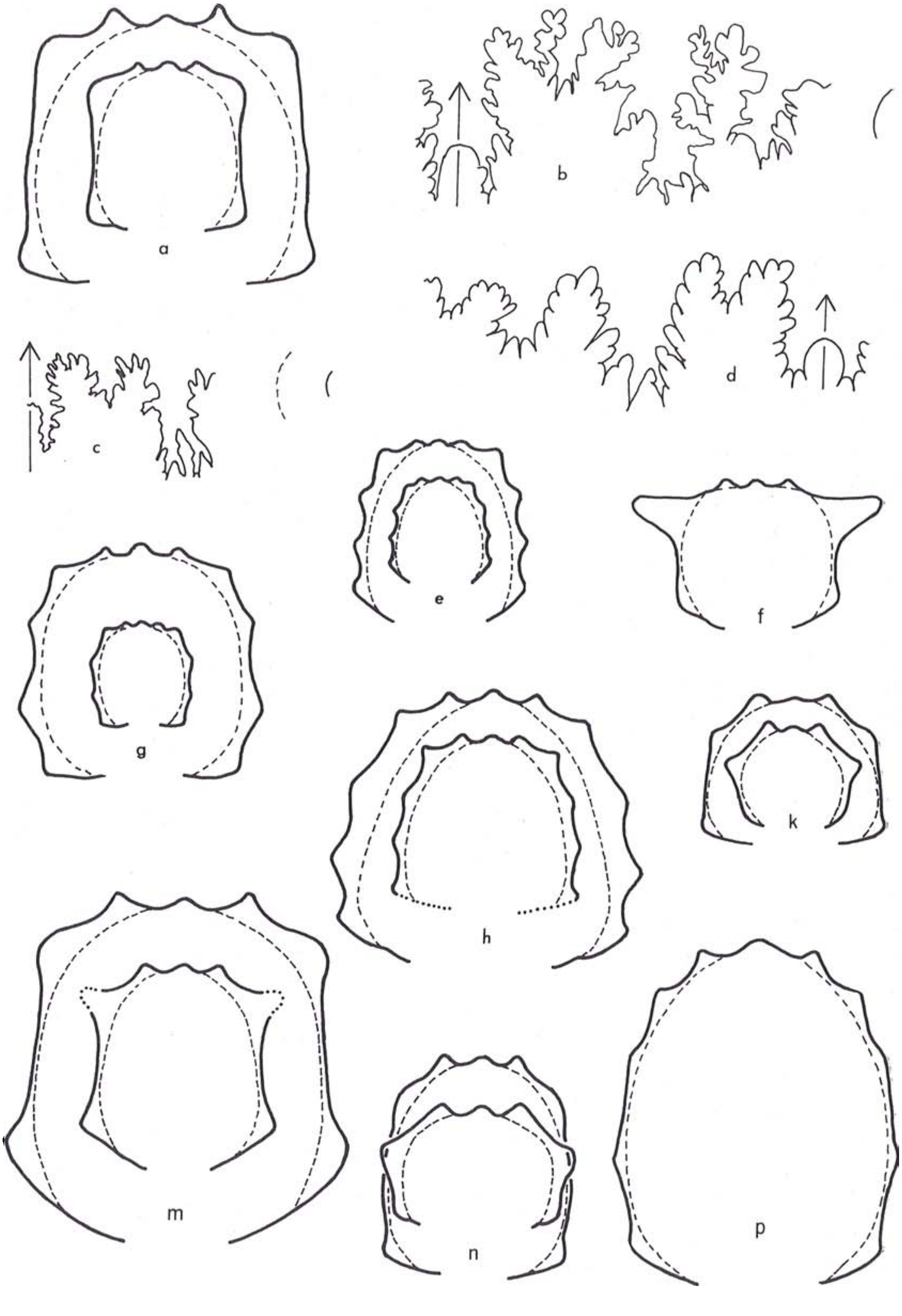
d—Texanites texanus texanus (Römer); suture from Römer's (1852) pl. 3, fig. 1c. Römer's reproduction is excellent when compared with the suture of the holotype (*see also* pl. 38, figs. 1, 2, and pl. 41, fig. 4); x1

f—Prionocycloceras adkinsae, n. sp.; whorl section of the holotype, WSA–94A (*see also* pl. 23, fig. 2); x1

k, n—Australiella welderi, n. sp.; whorl sections of UT–30479 (*see also* pl. 65, fig. 3, and pl. 68, figs. 4, 5), *k,* at diameters of 30 and 60 mm., and *n,* at diameters of 40 and 75 mm.; *all,* x1

m—Protexanites planatus (Lasswitz); whorl section of UT–30504 (*see also* pl. 26, figs. 3, 4, and pl. 37, figs. 2, 3) at diameters of 80 and 150 mm.; x1

p—Texanites stangeri (Baily); whorl section of WSA–92 (*see also* pl. 45, figs. 1–3) at a diameter of 200 mm.; x1


a
b
c
d
e
f
g
h
k
m
n
p

TEXT FIG. 26

a—*Submortoniceras vandaliaense*, n. sp.; whorl sections of the holotype, UT–30638 (*see also* pl. 55, figs. 6, 7) at a diameter of 94 mm.; x1

b, f, g—*Delawarella delawarensis* (Morton); *b*, whorl sections of UT–30627 at diameters of 18, 25, and 50 mm.; *g*, whorl section of BEG–34748 (*see also* text fig. 25b); *f*, whorl section of UT–19818 (*see also* pl. 61, fig. 1, and pl. 63, fig. 2); *all*, x1

c—*Delawarella sabinalensis*, n. sp.; whorl sections of the holotype, WSA–13 (*see also* pl. 63, figs. 1, 3, 4, and text figs. 20c and 21e); x1

d, e—*Submortoniceras vanuxemi* (Morton); *d*, whorl sections of UT–30607 (*see also* pl. 57, fig. 7; pl. 69, fig. 6; and text fig. 12e); *e*, whorl sections of a cast of the holotype (cast is UT–30617) at diameters of 20 and 35 mm.; *all*, x1

h—*Australiella pattoni*, n. sp.; suture of UT–18122A (*see also* pl. 66, figs. 5, 6, and text fig. 33a); x1

k—*Menabites walnutensis*, n. sp.; suture of the holotype, UT–18 (*see also* pl. 58, figs. 1, 4, and text figs. 20ef) at a diameter of 68 mm.; x1

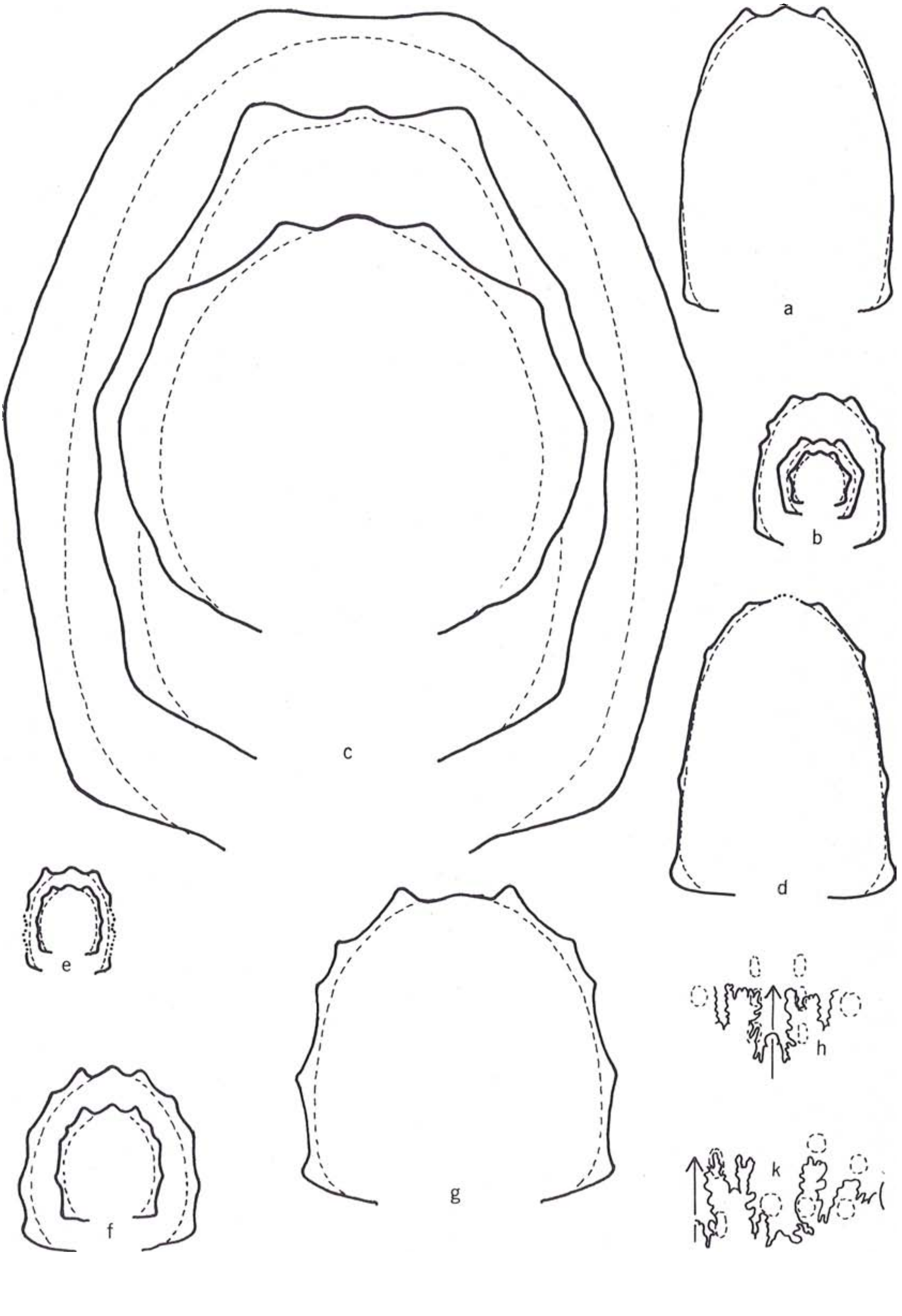

a
b
c
d
e
f
g
h
k

PLATE 54

FIG. *1—Menabites belli*, n. sp.; ventral view of WSA–1479 (*see also* pl. 58, fig. 2); x1

FIG. *2—Delawarella sabinalensis*, n. sp.; lateral view of a crushed internal mold in shale, UT–10731; x0.5

FIG. *3—Submortoniceras vanuxemi* (Morton); lateral view of UT–30478; x1

FIGS. *4–7—Texanites shiloensis*, n. sp.; lateral and ventral views of juvenile individual, UT–25 (*see also* pl. 70, fig. 6); x1

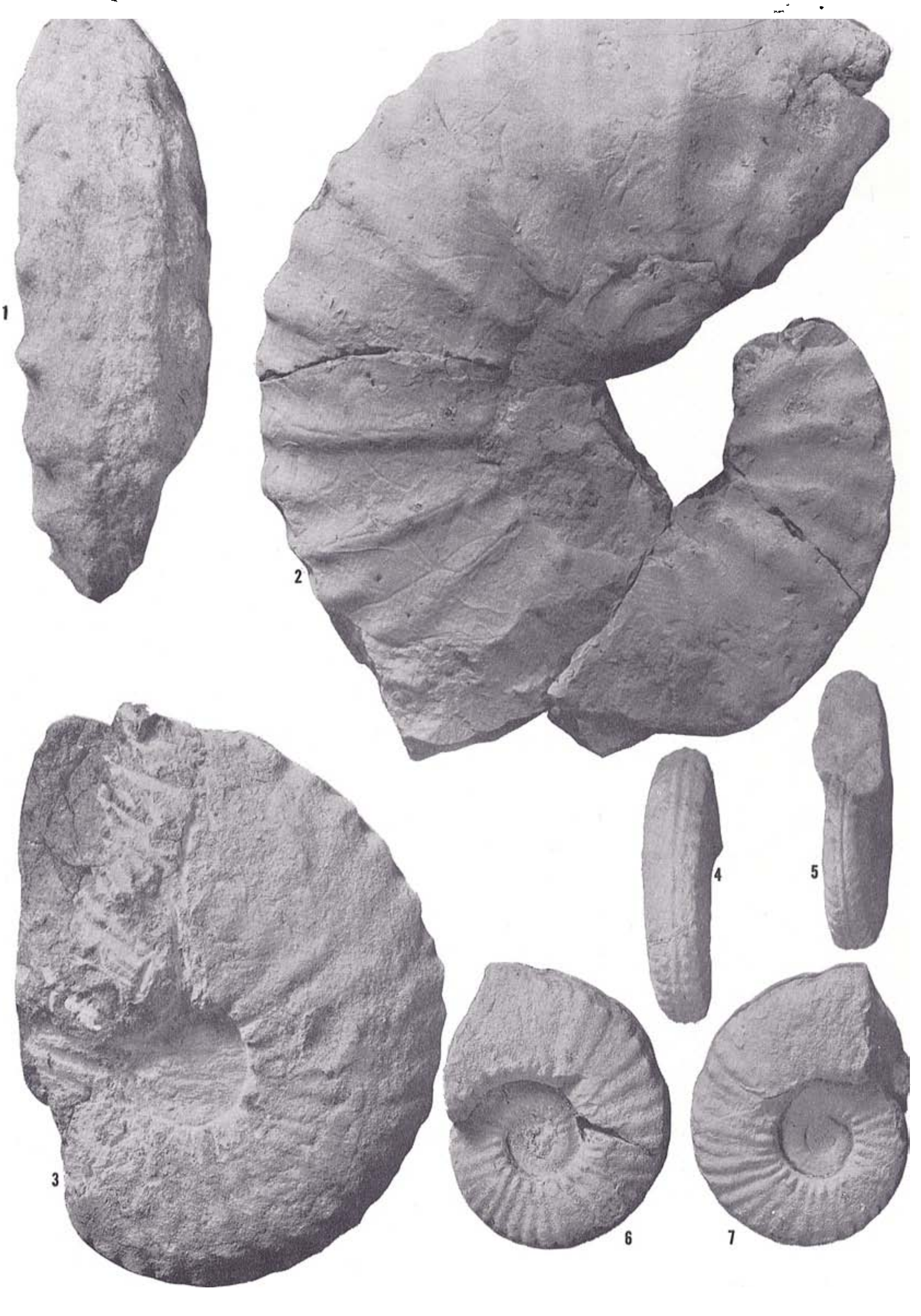

1
2
3
4
5
6
7

PLATE 55

FIGS. *1–4*—*Submortoniceras sancarlosense*, n. sp.; lateral and ventral views of *3* and *4*, inner whorls, and *1* and *2*, outer whorls, of the holotype, WSA–96 (*see also* pl. 62, fig. 3, and text figs. 20g and 27d); *1, 3, 4*, x1; *2*, x0.5

FIG. *5*—*Delawarella delawarensis* (Morton); ventral view of UT–30616, a cast of the holotype (*see also* pl. 61, fig. 3); x1

FIGS. *6, 7*—*Submortoniceras vandaliaense*, n. sp.; ventral and lateral views of the holotype, UT–30638 (*see also* text fig. 26a); x1

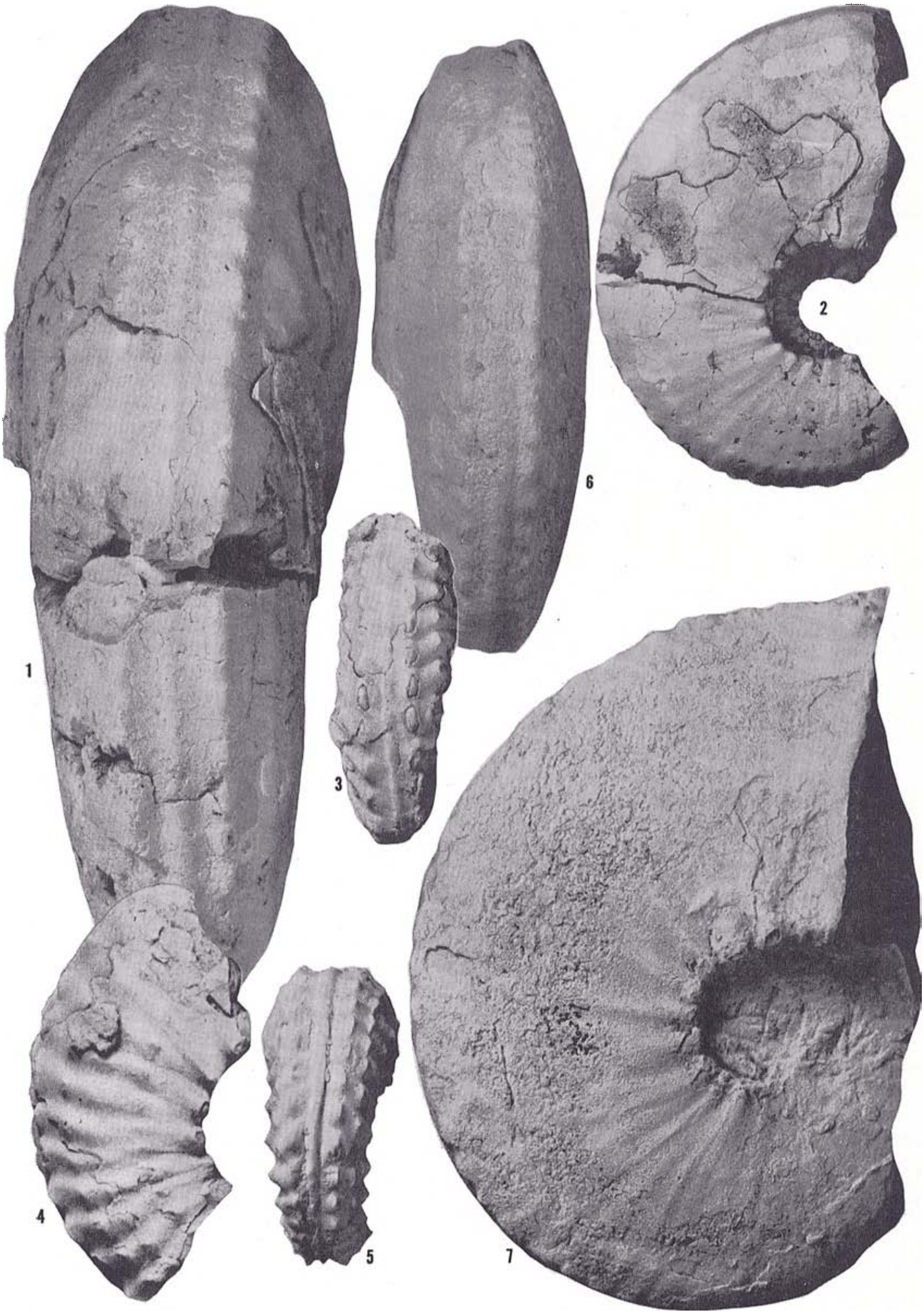

1
2
3
4
5
6
7

PLATE 56

FIGS. *1, 3, 4*—*Submortoniceras candelariae,* n. sp.; *1,* lateral view of UT–10304 (*see also* pl. 60, fig. 8, and text figs. 34af); *3, 4,* ventral and lateral views of the holotype, UT–10905 (*see also* text figs. 20b, 28a, 29e); *1, 3,* x0.5; *4,* x0.25

FIG. *2*—*Submortoniceras vanuxemi* (Morton); lateral view of UT–89 (*see also* pl. 69, figs. 1, 2); x1


1
2
3
4

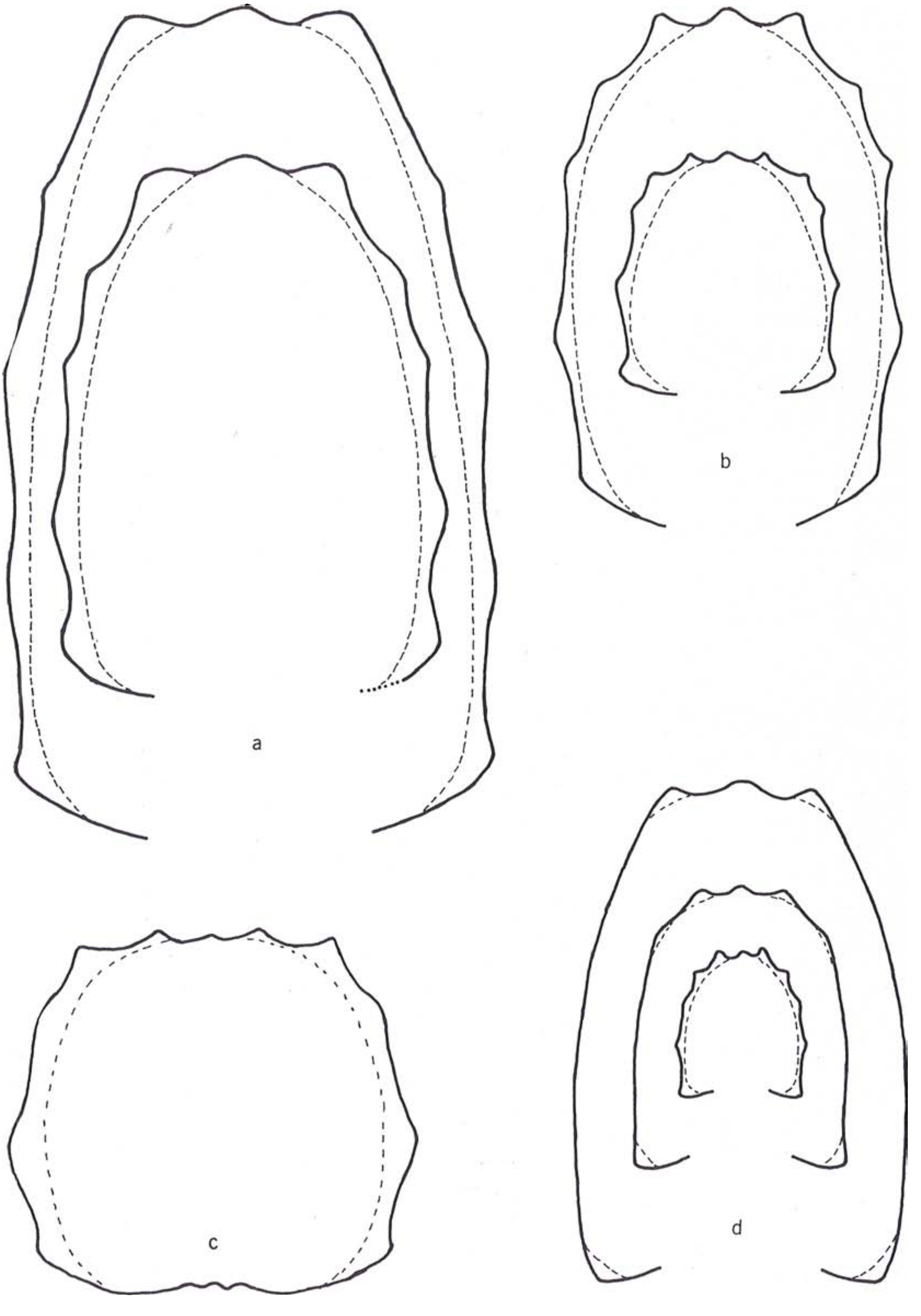
TEXT FIG. 27

a—*Menabites densinodosus* (Renz); whorl sections of UT–30477 (*see also* pl. 50, figs. 6, 7) at diameters of 200 and 350 mm.; x1

b—*Bevahites bevahensis* Collignon; whorl sections of UT–30511 (*see also* pl. 53, figs. 1, 2, 7) at diameters of 100 and 220 mm.; x1

c—*Delawarella delawarensis* (Morton); whorl section of a robust form, UT–1514 (*see also* pl. 61, figs. 2, 6); x1

d—*Submortoniceras sancarlosense,* n. sp.; whorl sections of the holotype, WSA–96 (*see also* pl. 55, figs. 1–4; pl. 62, fig. 3; and text fig. 20g), at diameters of 55, 100, and 155 mm.; x1


a
b
c
d

TEXT FIG. 28

a, f—*Submortoniceras candelariae*, n. sp.; *a*, suture of the holotype UT–10905 (*see also* pl. 56, figs. 3, 4, and text figs. 20b and 29e) at a diameter of 230 mm.; *f*, whorl section of UT–10902 (*see also* text fig. 29a); *both*, x1

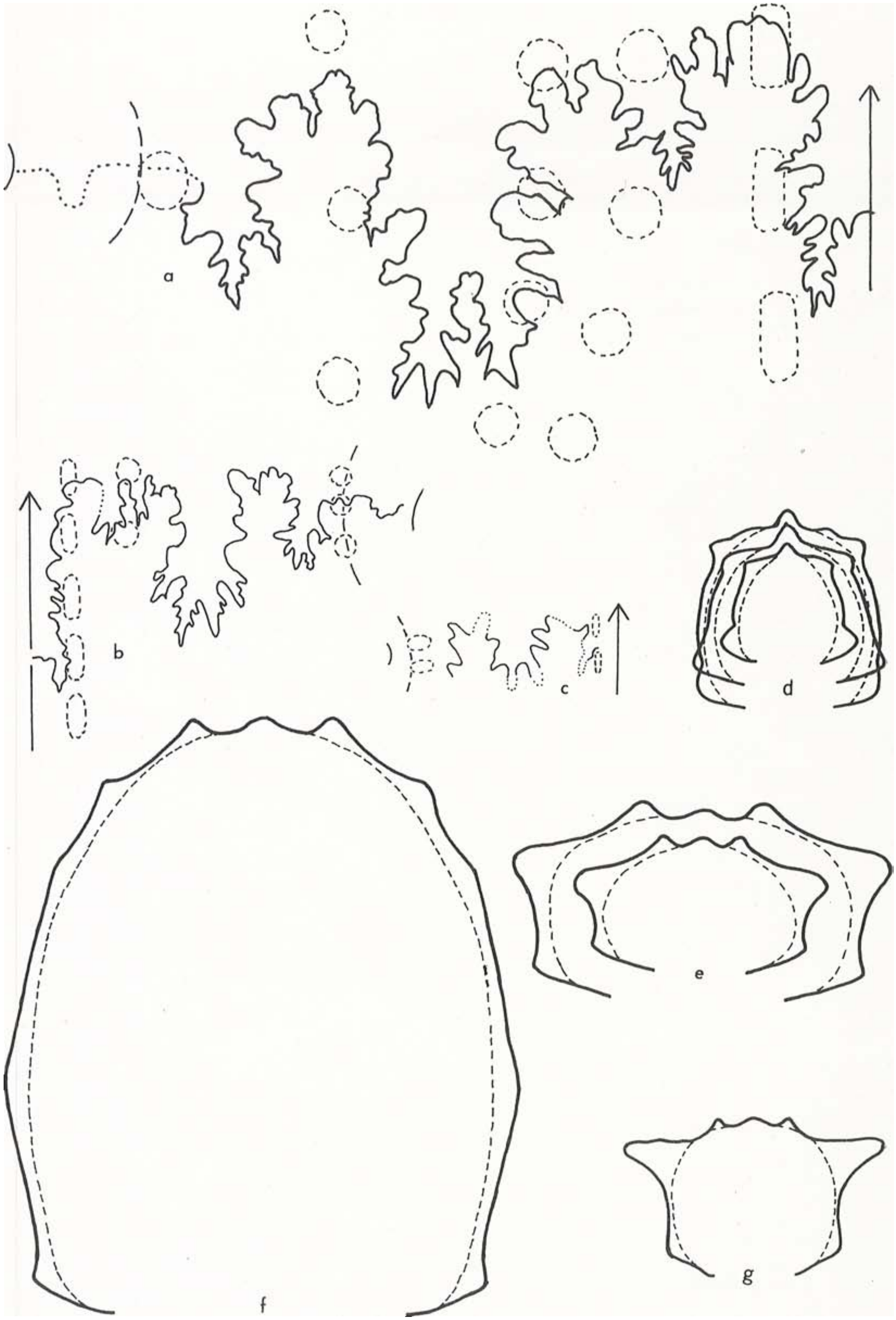
b—*Submortoniceras tequesquitense*, n. sp.; suture of the holotype, BEG–34742 (*see also* pl. 42, figs. 1, 2, and pl. 52, figs. 1, 2, 4), at a diameter of 100 mm.; x1

c—*Submortoniceras uddeni*, n. sp.; corroded suture of USNM–130742 from U. S. G. S. Mesozoic locality 16773 (*see also* pl. 59, figs. 1, 2, 4, 6) at a diameter of 60 mm.; x1

d—*Pseudoschloenbachia mexicana* (Renz); whorl sections of UT–18121 (*see also* pl. 30, figs. 2, 3; pl. 32, fig. 4; pl. 33, fig. 2; pl. 44, fig. 1) at diameters of 30, 50, and 70 mm.; x1

e—*Australiella austinensis*, n. sp.; whorl sections of the holotype, WSA–65 (*see also* pl. 65, fig. 6, and pl. 67, fig. 6), at diameters of 48 and 75 mm.; x1

g—*Prionocycloceras adkinsae*, n. sp.; whorl section of WSA–94 (*see also* pl. 23, fig. 1); x1


a
b
c
d
e
f
g

TEXT FIG. 29

a, e—Submortoniceras candelariae, n. sp.; *a,* suture of UT–10902 (*see also* text fig. 34f); *e,* whorl sections of the holotype, UT–10905 (*see also* pl. 56, figs. 3, 4, and text figs. 20b and 28a), at diameters of 224 and 320 and 440 mm.; *all,* x1

b, d—Pseudoschloenbachia mexicana (Renz); *b,* whorl sections and *d,* suture of UT–19821 (*see also* pl. 33, figs. 1, 5, 7); suture at a diameter of about 85 mm.; *all,* x1

c—Protexanites planatus (Lasswitz); whorl sections of UT–14398B (*see also* pl. 35, fig. 4) at diameters of 40 and 60 mm.; x1

f—Delawarella delawarensis (Morton); whorl sections of UT–19817 (*see also* pl. 61, figs. 4, 5), x1

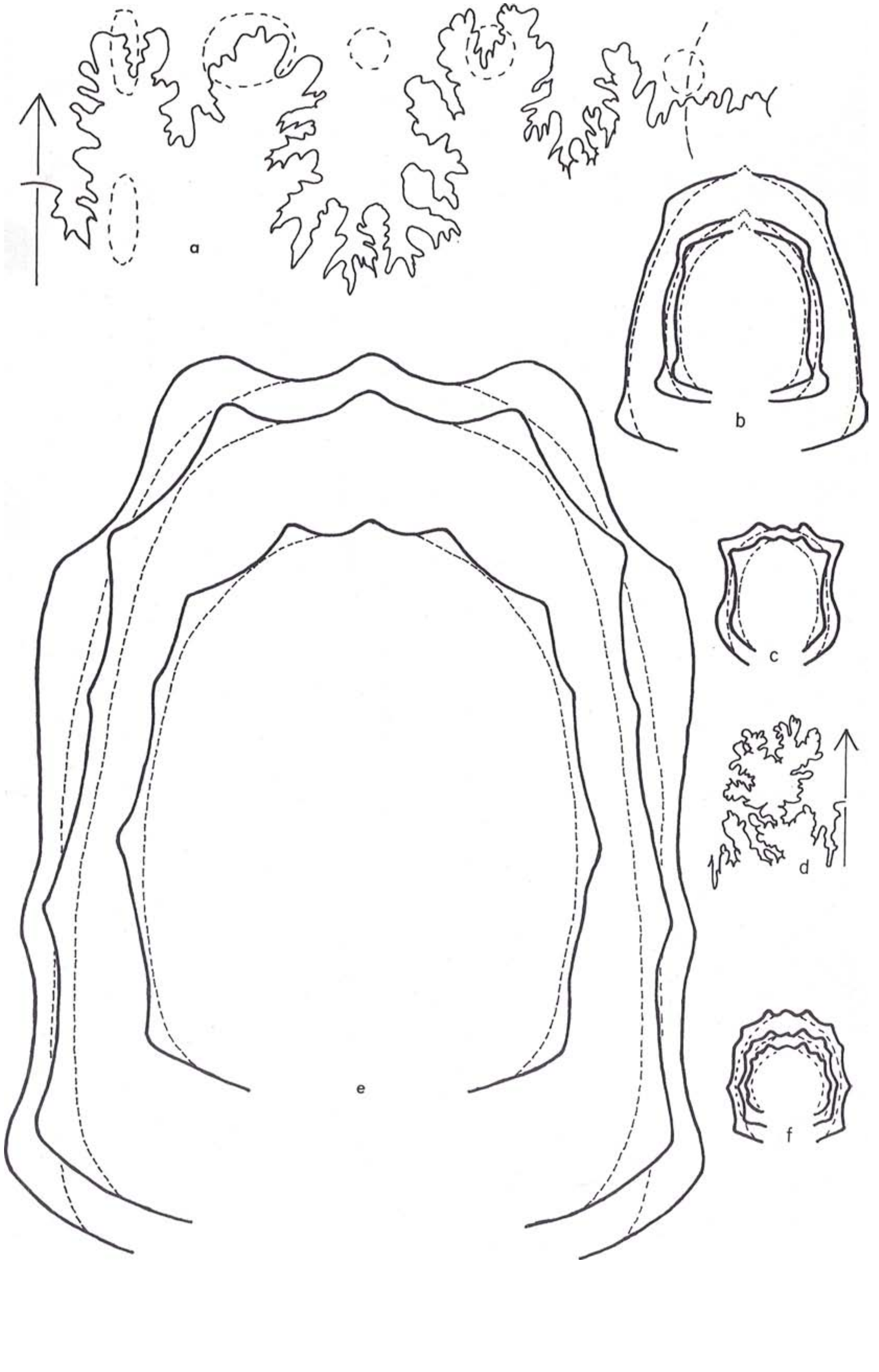

a
b
c
d
e
f

PLATE 57

FIGS. *1–3—Submortoniceras chicoense* (Trask); lateral and ventral views of WSA–64 (*see also* text fig. 12d), x1

FIG. *4—Submortoniceras tequesquitense*, n. sp.; lateral view of UT–30568, x1

FIG. *5—Texanites americanus* (Lasswitz); ventral view of neotype, UT–563 (*see also* pl. 44, figs. 2, 3, and text fig. 24c), x0.5

FIG. *6—Delawarella danei*, n. sp.; lateral view of inner whorls of the holotype, UT–30646 (*see also* pl. 62, figs. 1, 2; pl. 65, fig. 1; pl. 66, fig. 4; and text fig. 33b); x1

FIG. *7—Submortoniceras vanuxemi* (Morton); lateral view of UT–30607 (*see also* pl. 69, fig. 6, and text figs. 12e and 26d); x1

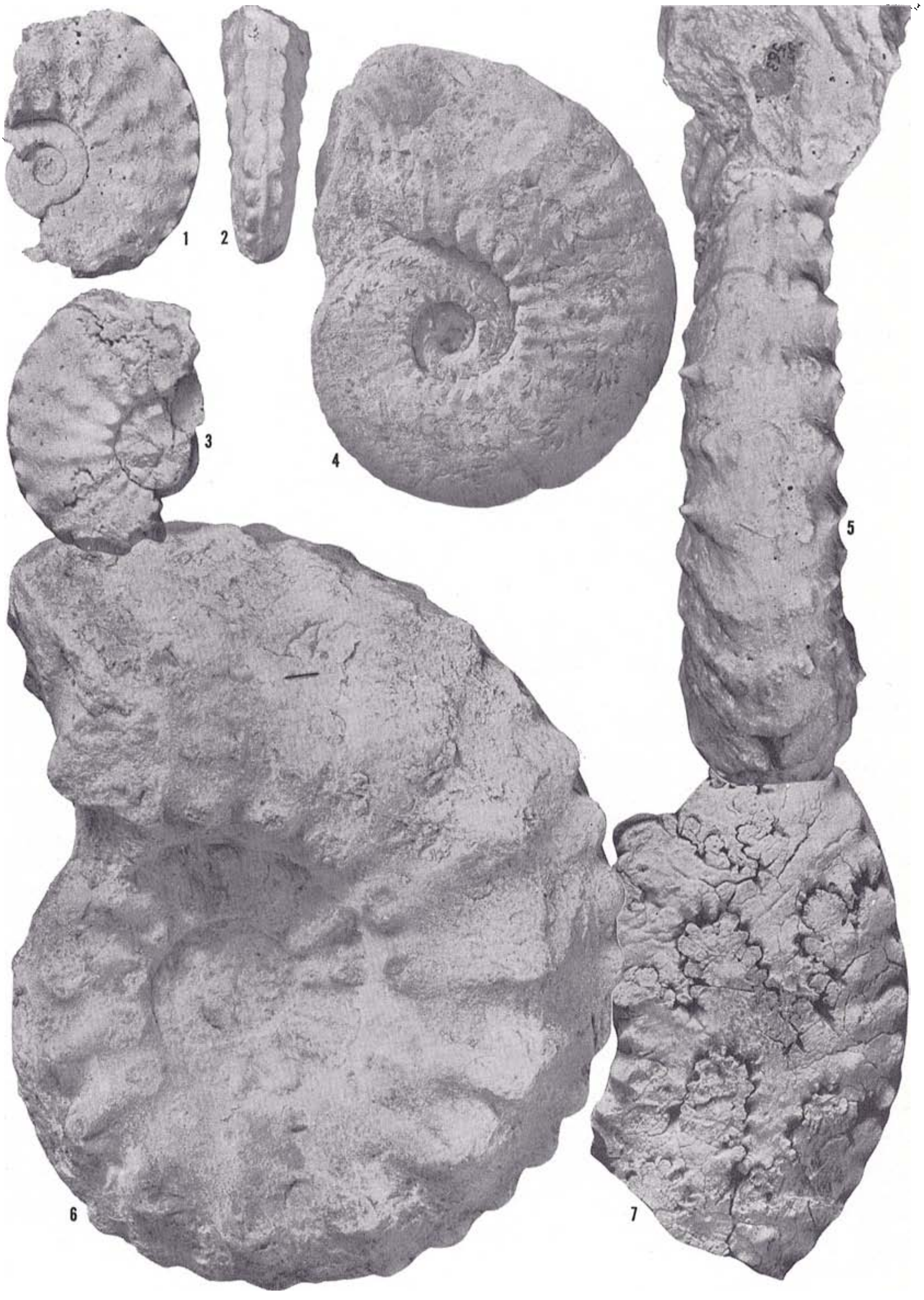

1
2
3
4
5
6
7

PLATE 58

FIGS. *1, 4*—*Menabites walnutensis*, n. sp.; lateral and ventral views of the holotype, UT–18 (*see also* text figs. 20ef and 26k); x1

FIG. *2*—*Menabites belli*, n. sp.; lateral view of WSA–1479 (*see also* pl. 54, fig. 1); x1

FIG. *3*—*Submortoniceras vanuxemi* (Morton); ventral view of UT–189 (*see also* pl. 67, fig. 3); x1

FIGS. *5, 6*—*Texanites lonsdalei*, n. sp.; lateral views of the holotype, UT–30474 (*see also* pl. 34, fig. 1; pl. 51, figs. 3–7; and text figs. 22ad); *5*, x1; *6*, x0.5


1
2
3
4
5
6

TEXT FIG. 30

Plots for 4 species of *Submortoniceras;* diameter of the conch plotted on the ordinate against HF (fig. 30a), U (fig. 30b), and HF/W (fig. 30c), on the abscissa. Crosses represent *Submortoniceras tequesquitense,* n. sp.; *x*'s, *S. uddeni,* n. sp.; circles, *S. mariscalense,* n. sp.; and dots, *S. vanuxemi* (Morton). In these species it is the ornamentation that produces specific characters, and, as illustrated by the figures, whorl shape is not important, except that even with crushed individuals, *S. uddeni* seems to develop much higher whorls early in its ontogeny.

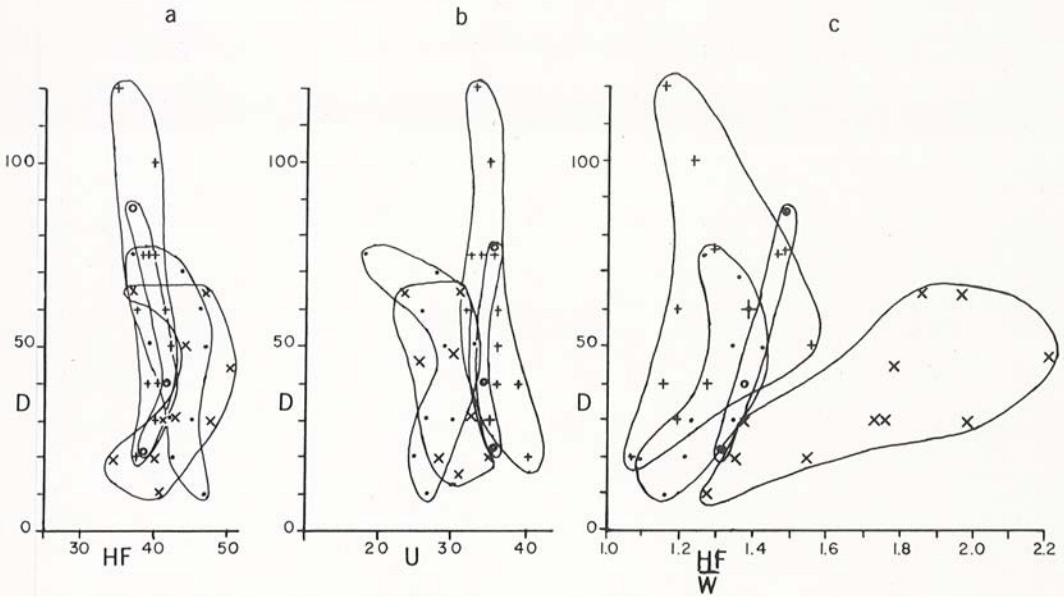

a
b
c
D
HF
U
HF/W
0
50
100
30
40
50
20
1.0
1.2
1.4
1.6
1.8
2.0
2.2

PLATE 59

FIGS. *1, 2, 4–9*—*Submortoniceras uddeni*, n. sp.; *1, 2, 4, 6,* lateral and ventral views of USNM–130742, an individual from U. S. G. S. Mesozoic locality 16773 (*see also* text fig. 28c); *5, 7–9,* lateral and ventral views of the holotype, USNM–130739, from U. S. G. S. Mesozoic locality 18938 (*see also* text fig. 14e), with a more open umbilicus; *all*, x1

FIG. *3*—*Submortoniceras mariscalense*, n. sp.; lateral view of the holotype, BEG–20478 (*see also* pl. 60, figs. 1, 4–6, and text figs. 14bf), x1


1
2
3
4
5
6
7
8
9

PLATE 60

FIGS. *1, 4–6—Submortoniceras mariscalense*, n. sp.; lateral and ventral views of the holotype, BEG–20478 (*see also* pl. 59, fig. 3, and text figs. 14bf); x1

FIGS. *2, 3, 7, 9, 10—Submortoniceras uddeni*, n. sp.; *2, 3, 7, 10*, ventral and lateral views of a smaller individual, USNM–130740, from U. S. G. S. Mesozoic locality 18938 (*see also* text fig. 14d); *9*, lateral view of a second small individual, USNM–130741, from U. S. G. S. Mesozoic locality 18938; *all*, x1

FIG. *8—Submortoniceras candelariae*, n. sp.; lateral view of UT–10304 (*see also* pl. 56, fig. 1, and text figs. 34af); x1

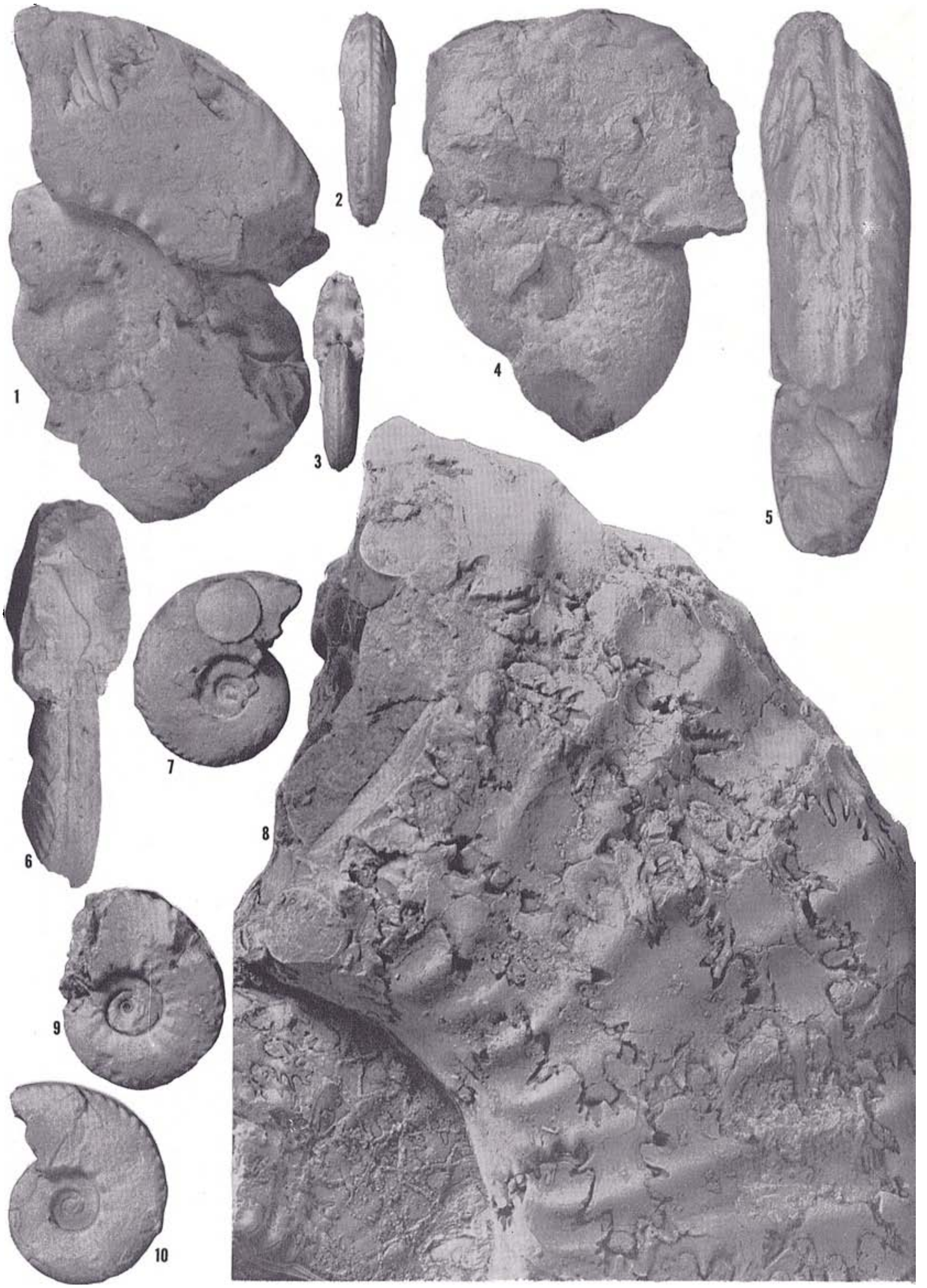

1
2
3
4
5
6
7
8
9
10

PLATE 61

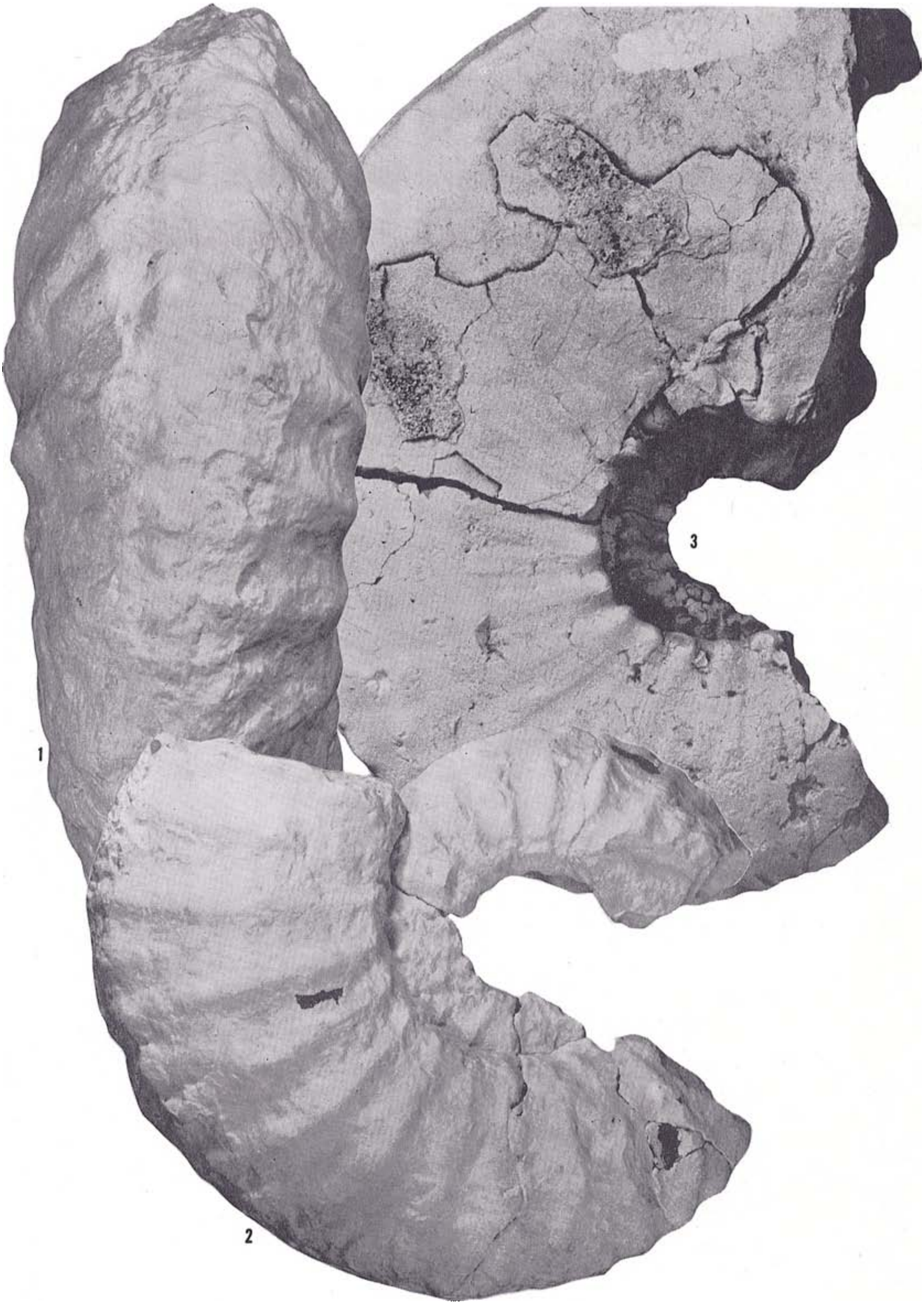
Figs. *1–6—Delawarella delawarensis* (Morton); *1*, ventral view of UT–19818 (*see also* pl. 63, fig. 2, and text fig. 26f); *2, 6*, lateral and ventral views of UT–1514 (*see also* text fig. 27c); *3*, lateral view of UT–30616 (*see also* pl. 55, fig. 5), a cast of the holotype; *4, 5*, ventral and lateral views of UT–19817 (*see also* text fig. 29f); *all*, x1


1
2
3
4
5
6

PLATE 62

FIGS. *1, 2*—*Delawarella danei*, n. sp.; ventral and lateral views of the outer whorl of UT–30646, the holotype (*see also* pl. 57, fig. 6; pl. 65, fig. 1; pl. 66, fig. 4; and text fig. 33b); *1*, x0.34; *2*, x0.25

FIG. *3*—*Submortoniceras sancarlosense*, n. sp.; lateral view of the holotype, WSA–96 (*see also* pl. 55, figs. 1–4, and text figs. 20g and 27d); x1


1
2
3

TEXT FIG. 31

Plots of 4 species of *Delawarella* and one species of *Australiella;* diameter on the ordinate axis against U (fig. 31a), HF (fig. 31b), rib count (fig. 31c), HF/W (fig. 31d), and W (fig. 31e), on the abscissa. Crosses represent *Delawarella delawarensis* (Morton); dots, *D. sabinalensis*, n. sp.; asterisks, *D. campaniensis* (Grossouvre); circles, *D. danei*, n. sp.; and *x*'s, *Australiella austinensis*, n. sp. The number of observations are too few for detailed interpretation. For each character the single specimen of *D. campaniensis* has the same measurements throughout all diameters, and this species is more compressed than others. *A. austinensis* is much thicker and more depressed than are species of *Delawarella.*

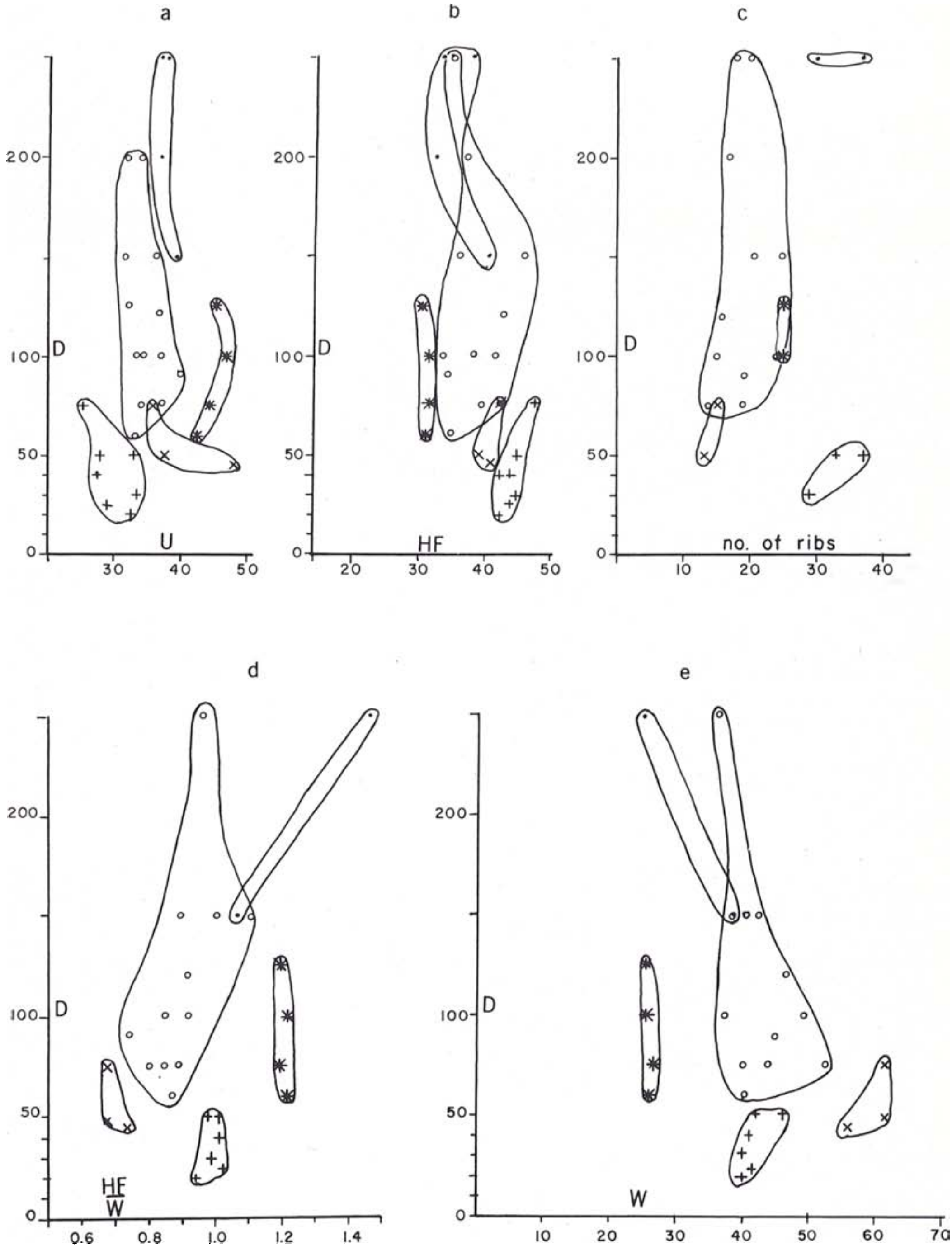

a
b
c
d
e
D
U
HF
no. of ribs
HF/W
W
0
50
100
200
10
20
30
40
50
60
70
0.6
0.8
1.0
1.2
1.4

PLATE 63

FIGS. *1, 3, 4*—*Delawarella sabinalensis,* n. sp.; ventral and lateral views of the holotype, WSA-13 (*see also* text figs. 20c, 21e, 26c); *1, 4,* x1; *3,* x0.5

FIG. *2*—*Delawarella delawarensis* (Morton); lateral view of UT-19818 (*see also* pl. 61, fig. 1, and text fig. 26f); x1


1
2
3
4

PLATE 64

FIGS. *1, 5*—*Delawarella danei*, n. sp.; *1*, lateral view of UT–30628 (*see also* pl. 65, fig. 2; pl. 66, fig. 3; and text fig. 24e); *5*, ventral view of eroded individual, UT–30674; *both*, x1

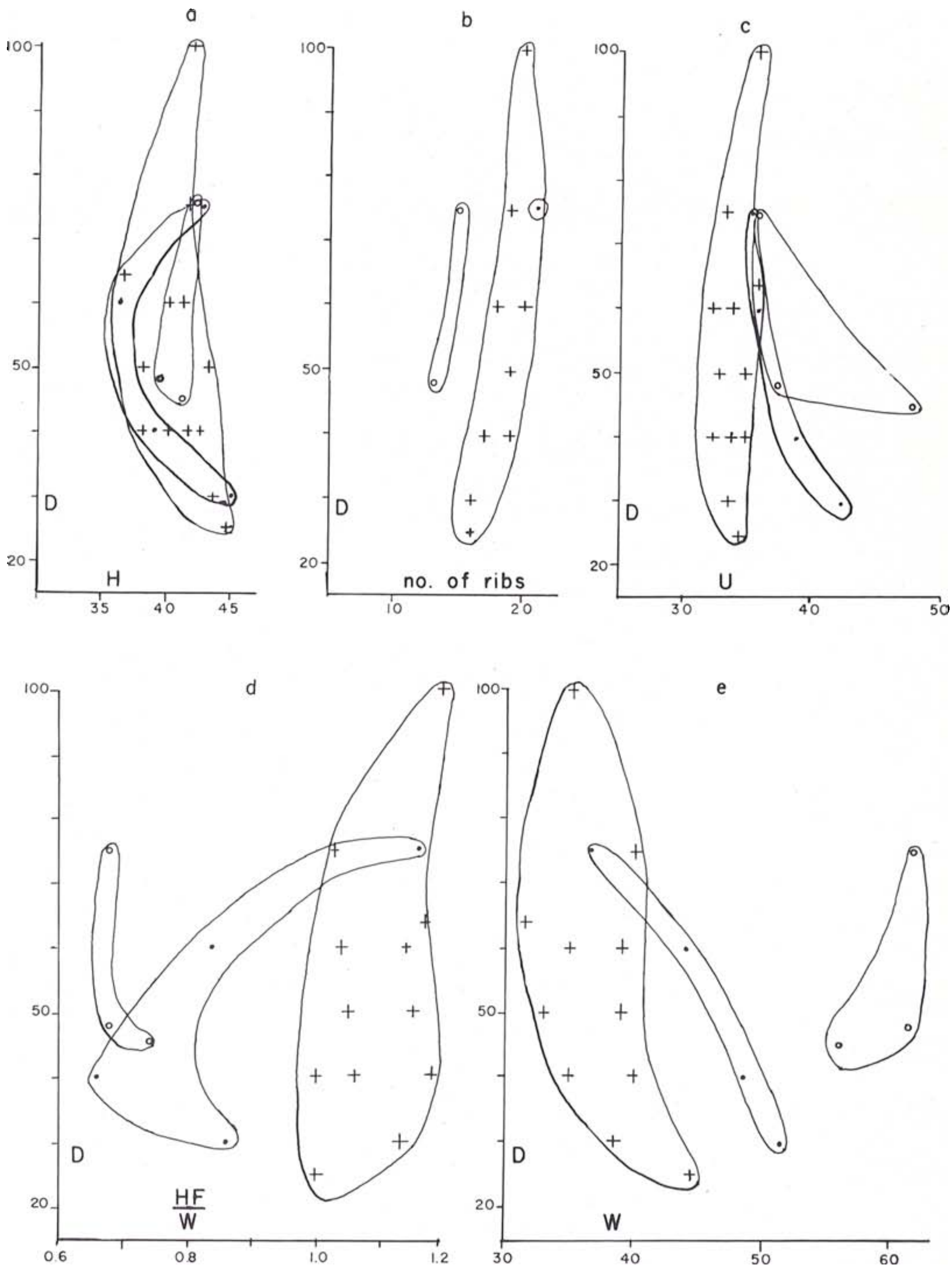
FIGS. *2, 6*—*Delawarella campaniensis* (Grossouvre); ventral views of BEG–34746 (*see also* pl. 67, fig. 2, and text figs. 24a and 25a); x1

FIGS. *3, 4*—*Australiella austinensis*, n. sp.; lateral views of inner and eroded outer whorl fragments of UT–2 (*see also* pl. 67, figs. 4, 5); x1


1
2
3
4
5
6

TEXT FIG. 32

Plots for three species of *Australiella.* Diameters on the ordinate against HF (fig. 32a), rib count (fig. 32b), U (fig. 32c), HF/W (fig. 32d), and W (fig. 32e), on the abscissa. Circles represent *Australiella austinensis,* n. sp.; crosses, *A. pattoni,* n. sp.; and dots, *A. welderi,* n. sp. The information is meager, but *A. austinensis* definitely is much more depressed, *A. pattoni* maintains consistent shape and ribbing during the ontogeny, whereas *A. welderi* has a marked change in W, HF/W, and HF, during its ontogeny.


a
b
c
d
e
D
H
no. of ribs
U
HF/W
W
100
50
20
35
40
45
10
20
30
40
50
0.6
0.8
1.0
1.2
60

TEXT FIG. 33

a, c—*Australiella pattoni*, n. sp.; *a*, whorl section of UT–18122A (*see also* pl. 66, figs. 5, 6, and text fig. 26h); *c*, whorl section of the holotype, UT–18122B (*see also* pl. 66, figs. 1, 2, and text fig. 24b); *both*, x1

b—*Delawarella danei*, n. sp.; whorl sections of the holotype, UT–30646 (*see also* pl. 57, fig. 6; pl. 62, figs. 1, 2; pl. 65, fig. 1; and pl. 66, fig. 4), at diameters of 60, 75, 100, 120, 250, 350, and 450 mm.; x1

d—*Prionocycloceras guayabanum* (Steinmann in Gerhardt); suture of WSA–137 (*see also* pl. 23, figs. 5, 6; pl. 27, figs. 2, 3; and text fig. 12a) at a diameter of 110 mm.; this is the last septum. x1

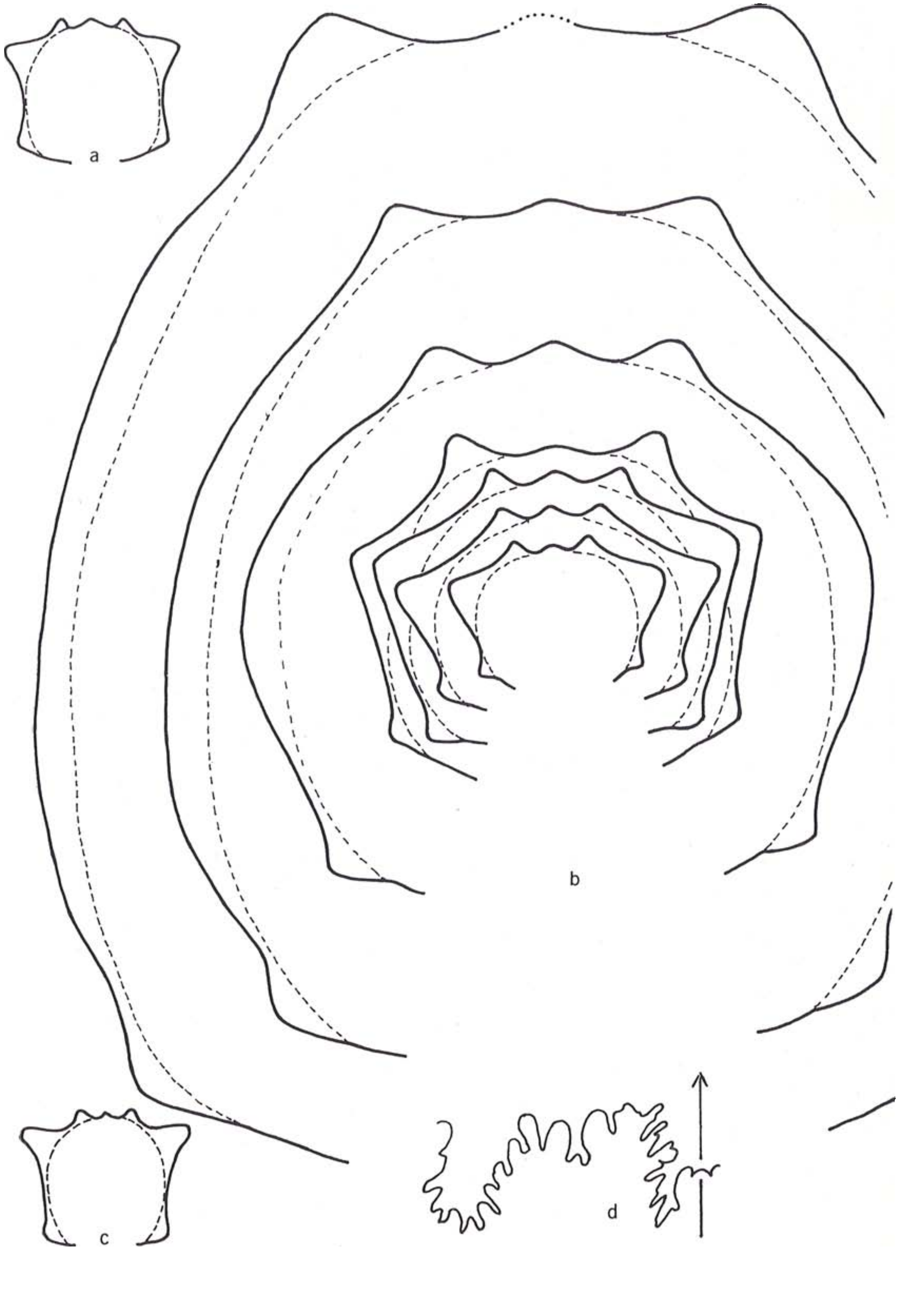

a
b
c
d

PLATE 65

FIGS. *1, 2*—*Delawarella danei*, n. sp.; *1*, ventral view of the internal whorls of the holotype, UT–30646 (*see also* pl. 57, fig. 6; pl. 62, figs. 1, 2; pl. 66, fig. 4; and text fig. 33b); *2*, lateral view of UT–30628 (*see also* pl. 64, fig. 1; pl. 66, fig. 3; and text fig. 24e); *both*, x1

FIG. *3*—*Australiella welderi*, n. sp.; ventral view of the holotype, UT–30479 (*see also* pl. 68, figs. 4, 5, and text fig. 25kn); x1

FIGS. *4, 5*—*Australiella pattoni*, n. sp.; ventral and lateral views of the inner whorls of BEG–20278 (*see also* pl. 68, figs. 1–3, 6, and text fig. 34g); x1

FIG. *6*—*Australiella austinensis*, n. sp.; ventral view of the holotype, WSA–65 (*see also* pl. 67, fig. 6, and text fig. 28e); x1


1
2
3
4
5
6

PLATE 66

FIGS. *1, 2, 5, 6*—*Australiella pattoni*, n. sp.; *1, 2,* lateral and ventral views of UT–18122B, the holotype (*see also* text figs. 24b and 33c); *5, 6,* lateral and ventral views of UT–18122A (*see also* text figs. 26h and 33a); *all*, x1

FIGS. *3, 4*—*Delawarella danei*, n. sp.; *3,* ventral view of UT–30628 (*see also* pl. 64, fig. 1; pl. 65, fig. 2; and text fig. 24e); *4,* ventral view of internal whorls of the holotype, UT–30646 (*see also* pl. 57, fig. 6; pl. 62, figs. 1, 2; pl. 65, fig. 1; and text fig. 33b); *all*, x1

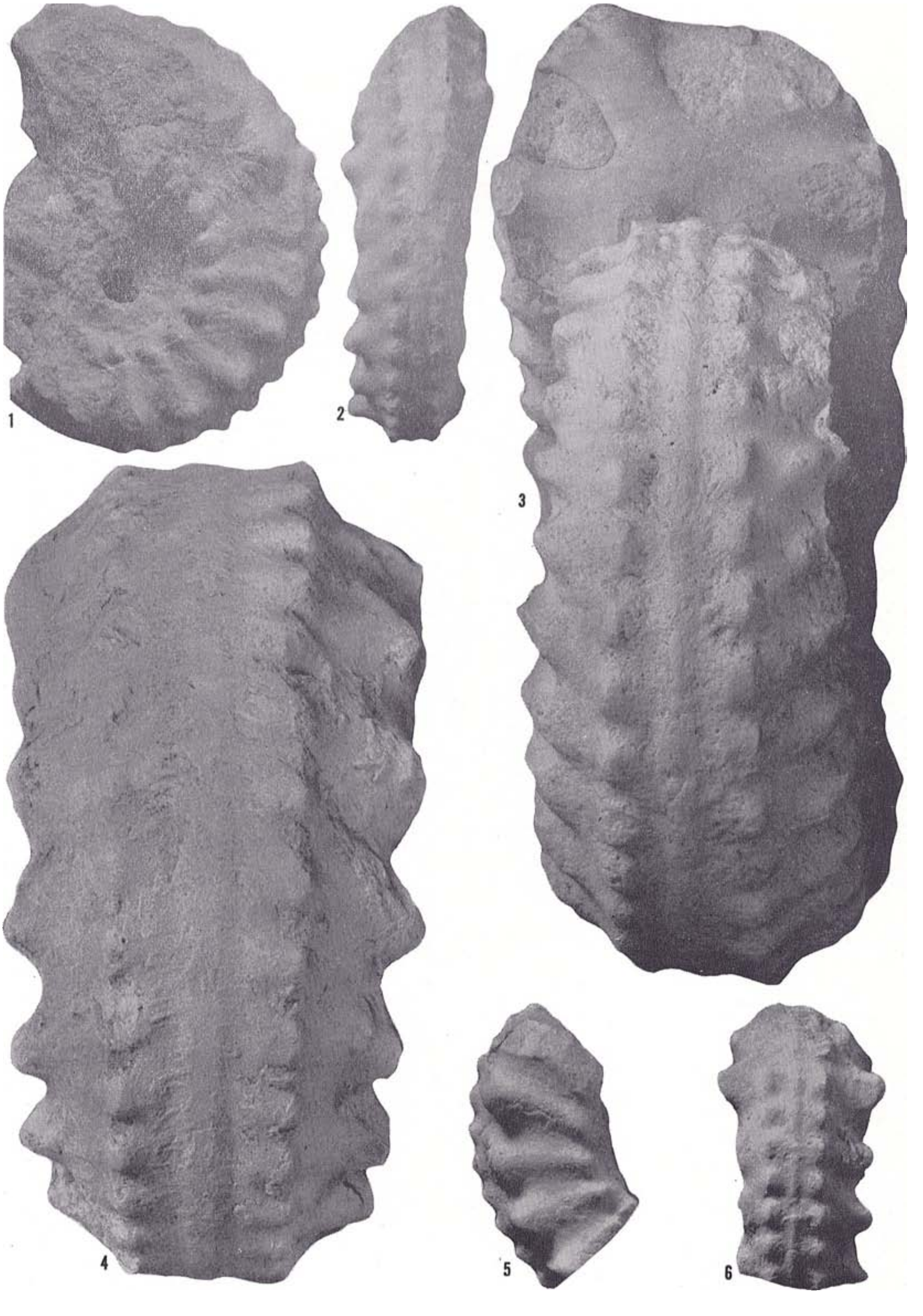

1
2
3
4
5
6

PLATE 67

FIG. *1*—*Prionocycloceras gabrielense*, n. sp.; ventral view of the holotype, UT–10808 (*see also* pl. 24, figs. 1–3); x0.35

FIG. *2*—*Delawarella campaniensis* (Grossouvre); lateral view of BEG–34746 (*see also* pl. 64, figs. 2, 6, and text figs. 24a and 25a); x1

FIG. *3*—*Submortoniceras vanuxemi* (Morton): lateral view of UT–189 (*see also* pl. 58, fig. 3); x1

FIGS. *4–6*—*Australiella austinensis*, n. sp.; *4*, *5*, ventral and dorsal views of smaller whorl fragment of UT–2 (*see also* pl. 64, figs. 3, 4); *6*, lateral view of the holotype, WSA–65 (*see also* pl. 65, fig. 6, and text fig. 28e); *all*, x1


1
2
3
4
5
6

TEXT FIG. 34

a, f—*Submortoniceras candelariae,* n. sp.; suture and whorl sections of UT–10304 (*see also* pl. 56, fig. 1, and pl. 60, fig. 8); suture at a diameter of 250 mm.; whorl sections at diameters of 140 and 270 mm.; *all,* x1

b—*Bevahites costatus* Collignon *coahuilaensis,* n. subsp.; whorl sections of the holotype, BEG–20288 (*see also* pl. 47, figs. 1–4, and pl. 71, fig. 5), at diameters of 50, 90, and 132 mm.; x1

c—*Texanites stangeri* (Baily) *densicostus* (Spath); whorl sections of WSA–201 (*see also* pl. 43, figs. 2, 4) at diameters of 75 and 125 mm.; x1

d, g—*Australiella pattoni,* n. sp.; *d,* whorl sections of BEG–34747 at diameters of 30, 40, and 60 mm.; *g,* whorl sections of BEG–20278 (*see also* pl. 65, figs. 4, 5, and pl. 68, figs. 1–3, 6); *both,* x1

e—*Prionocycloceras adkinsae,* n. sp.; whorl section of WSA–94 (*see also* pl. 23, fig. 4); x1

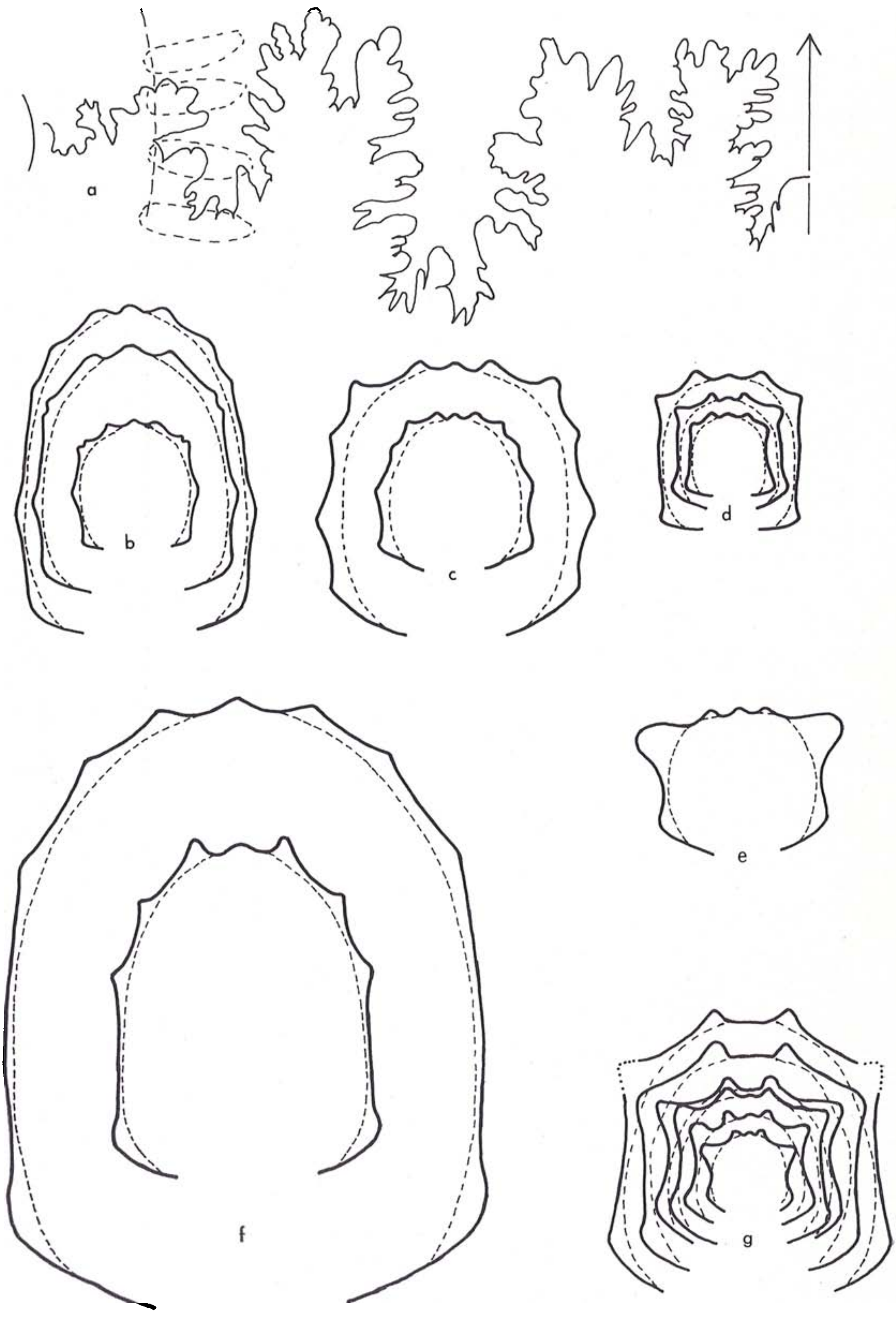
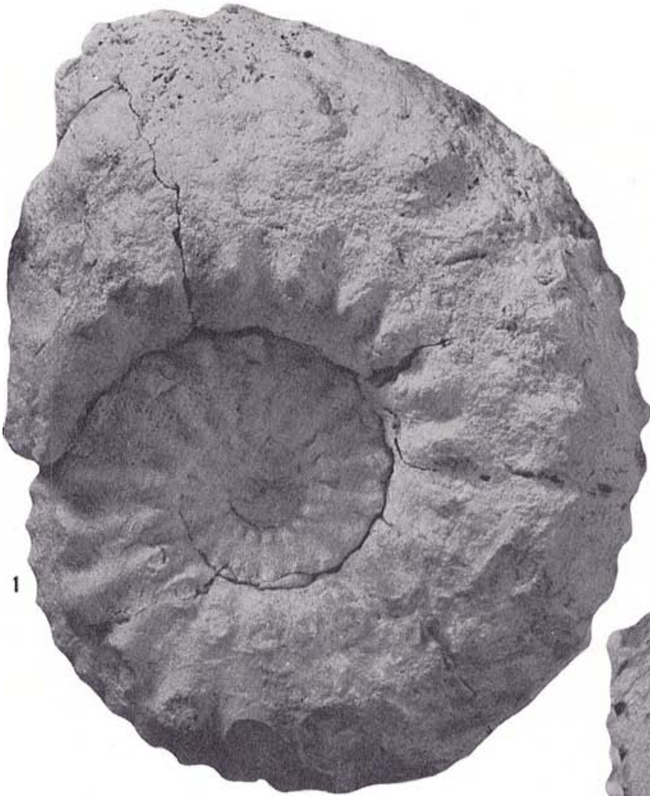
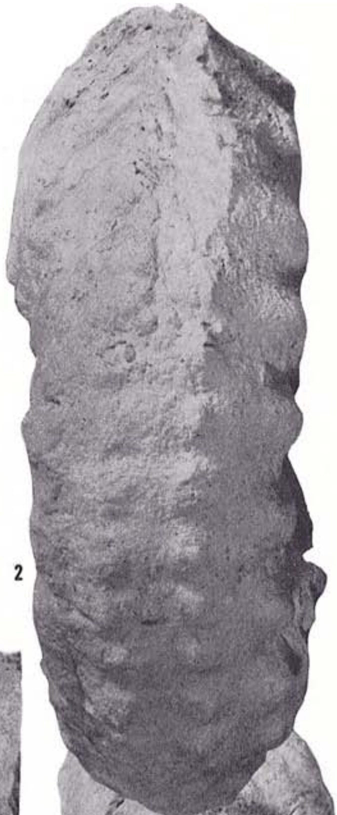

a
b
c
d
e
f
g

PLATE 68

FIGS. *1–3, 6*—*Australiella pattoni*, n. sp.; lateral and ventral views of BEG–20278 (*see also* pl. 65, figs. 4, 5, and text fig. 34g); x1

FIGS. *4, 5*—*Australiella welderi*, n. sp.; lateral and ventral views of the holotype, UT–30479 (*see also*, pl. 65, fig. 3, and text figs. 25kn); x1


1


2


3


4


5


6

PLATE 69

FIGS. *1, 2, 6*—*Submortoniceras vanuxemi* (Morton); *1, 2,* ventral views of UT–89 (*see also* pl. 56, fig. 2); *6,* ventral view of UT–30607 (*see also* pl. 57, fig. 7, and text figs. 12e and 26d); x1

FIGS. *3–5*—*Defordiceras hazzardi,* n. gen., and n. sp.; lateral and ventral views of the holotype, BEG–20285 (*see also* text figs. 21bf); *3, 4,* x0.5; *5,* x1


2
3
4
5
6

PLATE 70

FIG. *1*—*Submortoniceras tequesquitense*, n. sp.; ventral view of BEG–34743 (*see also* pl. 28, fig. 1); x1

FIGS. *2–4, 7*—*Menabites belli*, n. sp.; ventral and lateral views of the holotype, UT–13 (*see also* text fig. 15a); *2–4*, x1; *7*, outer whorl, x0.5

FIGS. *5, 6, 8*—*Texanites shiloensis*, n. sp.; *5*, ventral view of UT–1696 (*see also* pl. 46, figs. 2–4 and text fig. 24d); *6*, lateral view of UT-25 (*see also* pl. 54, figs. 4–7); *8*, ventral view of the holotype, UT–1986 (*see also* pl. 46, fig. 1); *5*, x1; *6*, x2; *8*, x0.25


1
2
3
4
5
6
7
8

PLATE 71

FIGS. *1–4—Texanites stangeri* (Baily) *densicostus* (Spath); *1, 4*, ventral and lateral views of WSA–49 (*see also* pl. 43, fig. 3; pl. 48, fig. 5; and text fig. 25g); *2*, ventral view of BEG–17503 (*see also* pl. 42, figs. 3, 4); *3*, lateral view of BEG–20282 (*see also* pl. 48, figs. 2, 6, and text fig. 25e); *1, 3, 4*, x1; *2*, x0.5

FIG. *5—Bevahites costatus* Collignon *coahuilaensis*, n. subsp.; lateral view of outer whorl of the holotype of the subspecies, BEG–20288 (*see also* pl. 47, figs. 1–4, and text fig. 34b); x0.5


1
2
3
4
5

PLATE 72

FIGS. *1–3, 6, 7*—*Texasia dentatocarinata* (Romer); *1, 2, 7,* lateral and ventral views of WSA-65 (*see also* text fig. 10p); *3, 6,* lateral views of a cast of the holotype (*see also* pl. 73, figs. 5, 6, text figs. 10q and 11b) on deposit in the Bureau of Economic Geology; *all,* x1

FIG. *4*—*Manambolites ricensis,* n. sp.; ventral view of UT-32582 (*see also* pl. 74, fig. 2, and text figs. 8f and 11h); x1

FIG. *5*—*Eulophoceras wollmanae,* n. sp.; ventral view of the large individual in Miss Wollman's collection (*see also* pl. 74, figs. 3, 5, and text figs. 11gs); x0.5

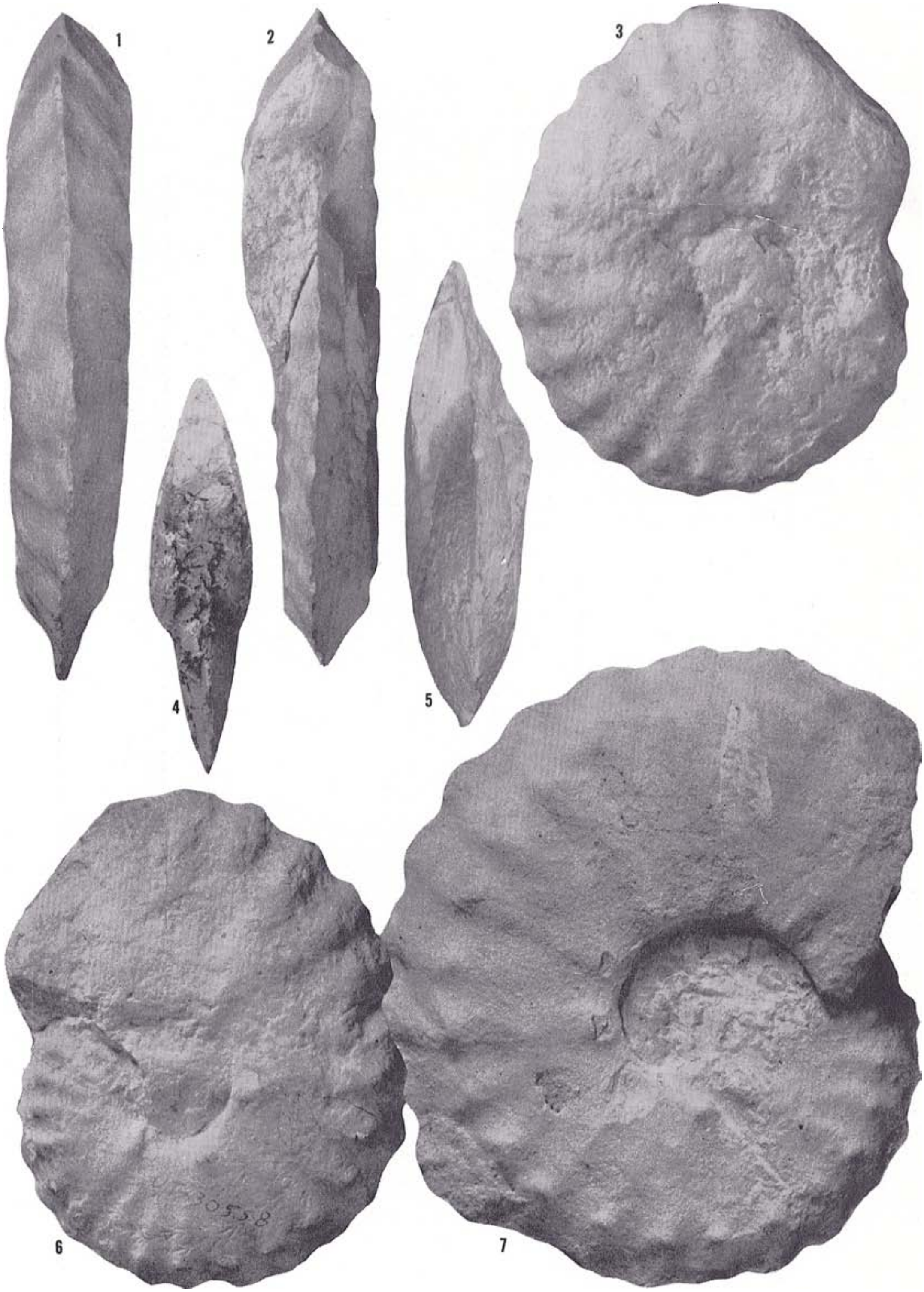

1
2
3
4
5
6
7

PLATE 73

FIGS. *1–3, 5, 6, 10*—*Texasia dentatocarinata* (Romer); *1, 2,* lateral and ventral views of UT–19873 (*see also* text fig. 10h); *3, 10,* ventral and lateral views of UT–30566; *5, 6,* ventral views of a cast of the holotype (*see also* pl. 72, figs. 3, 6, and text figs. 10q and 11b), on deposit in the Bureau of Economic Geology; *all,* x1

FIGS. *4, 11*—*Pseudoschloenbachia* sp.; ventral and lateral views of BEG–20286 (*see also* pl. 75, fig. 6); x1

FIGS. *7, 8, 12*—*Pseudoschloenbachia wilsoni,* n. sp.; *7,* ventral view of the holotype, UT–30596 (*see also* pl. 75, fig. 9, and text fig. 10m); *8, 12,* lateral and ventral views of a small individual, UT–19801; *all,* x1

FIG. *9*—*Glyptoxoceras ellisoni,* n. sp.; ventral view of the holotype, UT–182 (*see also* pl. 78, fig. 6); x1


1
2
3
4
5
6
7
8
9
10
11
12

PLATE 74

FIGS. *1, 3–6*—*Eulophoceras wollmanae,* n. sp.; *1, 4, 6,* ventral and lateral views of the small specimen in Miss Wollman's collection (*see also* text figs. 11cm); *3, 5,* lateral and ventral views of the holotype, also in Miss Wollman's collection (*see also* pl. 72, fig. 5, and text figs. 11gs); *1, 3, 4, 6,* x1; *5,* x0.5

FIG. *2*—*Manambolites ricensis,* n. sp.; lateral view of UT–32582 (*see also* pl. 72, fig. 4, and text figs. 8f, 11h); x1


1
2
3
4
5
6

PLATE 75

FIGS. *1–4—Pseudoschloenbachia chispaensis* Adkins; *1,* ventral view of UT–19803 (*see also* text fig. 11r); *2, 4,* ventral and lateral views of UT–19816 (*see also* text fig. 11p); *3,* ventral view of UT–19888 (*see also* pl. 76, fig. 6, and text fig. 11k); *all,* x1

FIGS. *5, 7–9—Pseudoschloenbachia wilsoni,* n. sp.; *5, 7, 8,* ventral and lateral views of UT–28 (*see also* text fig. 10j); *9,* lateral view of the holotype, UT–30596 (*see also* pl. 73, fig. 7, and text fig. 10m); *all,* x1

FIG. *6—Pseudoschloenbachia* sp.; lateral view of BEG–20286 (*see also* pl. 73, figs. 4, 11); x1

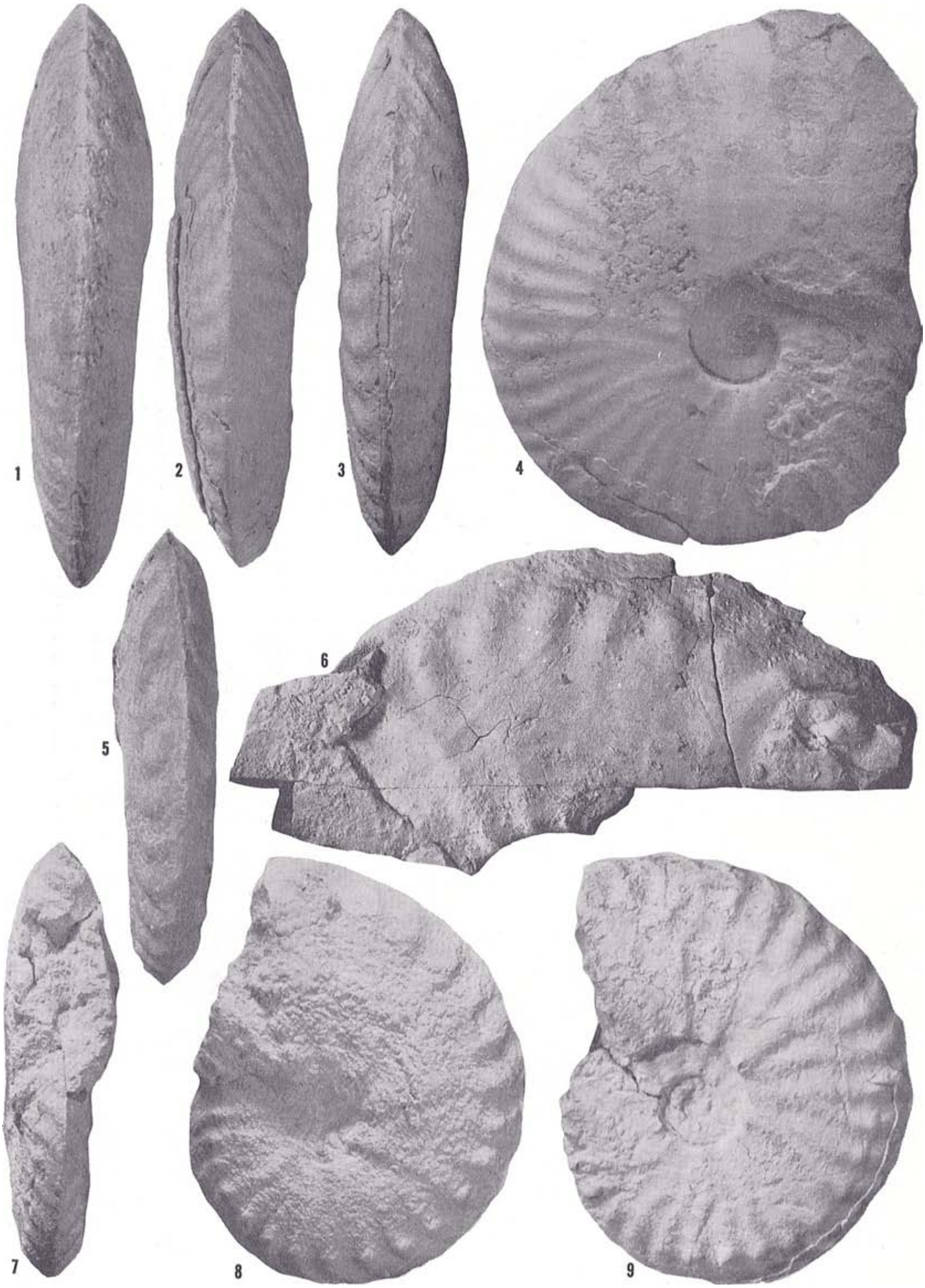

1
2
3
4
5
6
7
8
9

PLATE 76

FIGS. *1–4, 6*—*Pseudoschloenbachia chispaensis* Adkins; *1, 3*, sectional view of UT–19820 (*see also* text fig. 10e); *2, 4*, ventral and lateral views of the holotype, BEG–3009 (*see also* text figs. 10n and 11d); *6*, lateral view of UT–19888 (*see also* pl. 75, fig. 3, and text fig. 11k); *1, 2, 4, 6*, x1; *3*, x2.

FIG. *5*—*Nowakites* ? sp. cfr. *N. flaccidicostus* (Römer); ventral view of UT–19805 (*see also* pl. 16, figs. 5, 6); x1

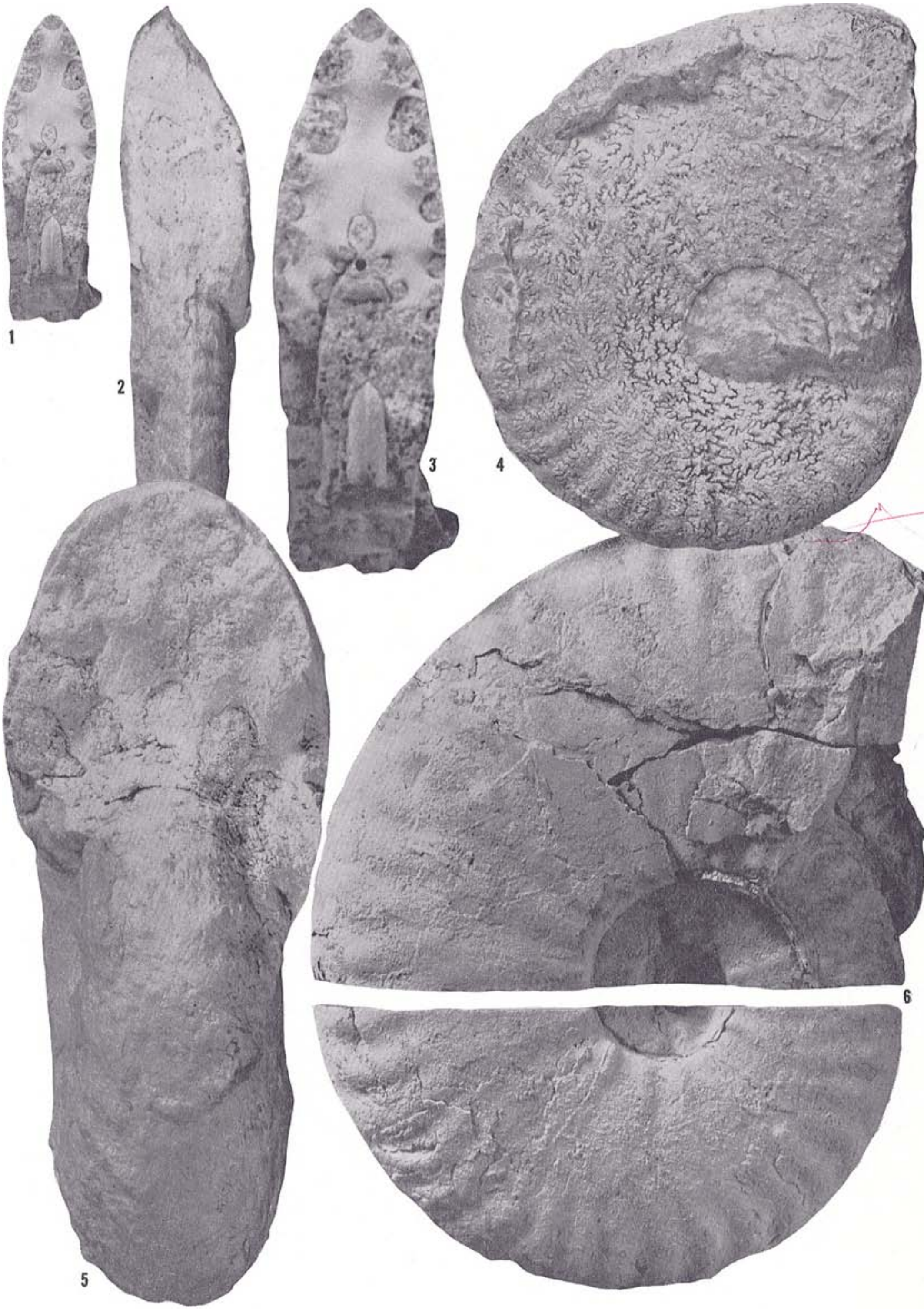
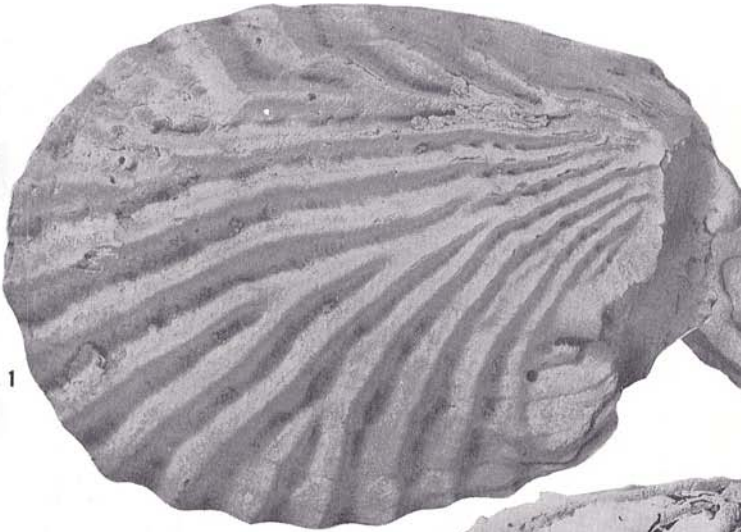

1
2
3
4
5
6

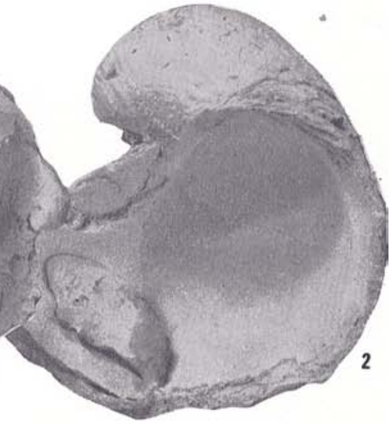
PLATE 77

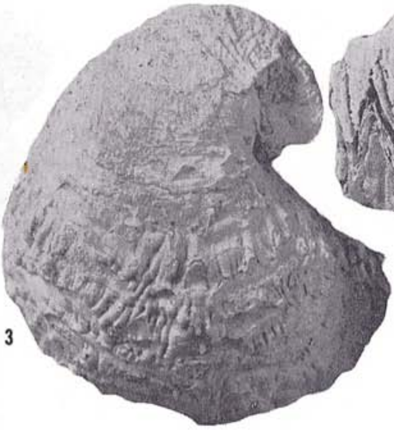
FIGS. *1, 4*—*Lopha travisana* (Stephenson); *1*, external view of right valve and *4*, dorsal view of UT–21; x1

FIGS. *2, 3, 5*—*Exogyra ponderosa upatoiensis* Stephenson; *2, 3*, internal and external views of left valve of UT–30724; *5*, external view of left valve of UT–10622; *all*, x1

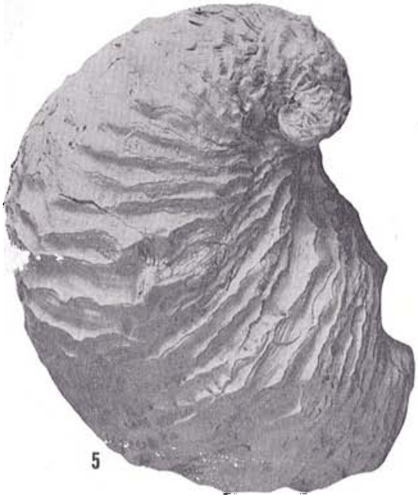
FIG. *6*—*Exogyra ponderosa erraticostata* Stephenson; external view of left valve of UT–30510 (*see also* pl. 79, fig. 4); x1


1


2


3


4


5


6

PLATE 78

FIGS. *1, 8*—*Exogyra ponderosa erraticostata* Stephenson; *1, 8,* interior and exterior views of left valve of UT–1722A; *all,* x1

FIG. *2*—*Stantonoceras sancarlosense* (Hyatt); ventral view of UT–30726 (*see also* pl. 17, fig. 6, and pl. 21, fig. 7), x1

FIGS. *3, 5*—*Exogyra ponderosa upatoiensis* Stephenson; *3,* external view of left valve of UT–1722B (*see also* pl. 80, fig. 1); *5,* external view of left valve of UT–10349; *all,* x1

FIG. *4*—*Pycnodonte convexa* (Morton); external view of right valve of UT–1721 (*see also* pl. 80, fig. 2), x1

FIG. *6*—*Glyptoxoceras ellisoni,* n. sp.; view of the holotype, UT–182 (*see also* pl. 73, fig. 9), x1

FIG. *7*—*Pycnodonte aucella* (Römer); external view of left valve of UT–10357 (*see also* pl. 21, fig. 5), x1

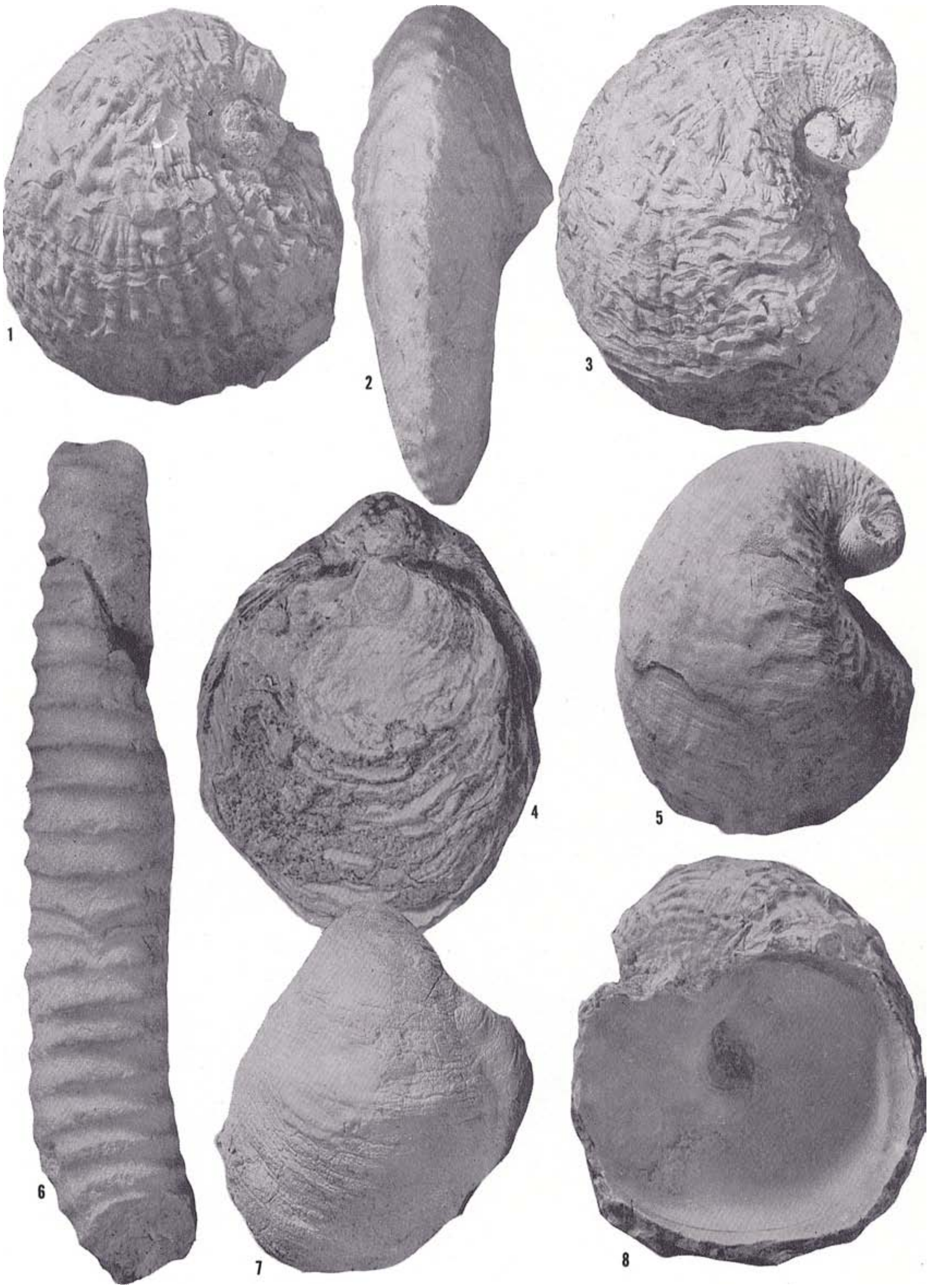


PLATE 79

Figs. *1, 3, 5*—*Cyprimeria roddai,* n. sp.; *1, 3,* interior and exterior of right valve of the holotype, UT–19886; *5,* interior of left valve of UT–19885; *all,* x1

Figs. *2, 6*—*Pycnodonte aucella* (Römer); *2,* interior of left valve of UT–1722 (*see also* pl. 21, fig. 8); *6,* interior of left valve of UT–10351 (*see also* pl. 22, fig. 3); *both,* x1

Fig. *4*—*Exogyra ponderosa erraticostata* Stephenson; internal view of left valve of UT–30510 (*see also* pl. 77, fig. 6), from the Pecan Gap chalk at Walnut Hill, Travis County, x1


1
2
3
4
5
6

PLATE 80

FIG. *1*—*Exogyra ponderosa upatoiensis* Stephenson; internal view of left valve of UT–1722B (*see also* pl. 78, fig. 3); x1

FIG. *2*—*Pycnodonte convexa* (Morton); external view of left valve of UT–1721 (*see also* pl. 78, fig. 4); x1

FIGS. *3, 4*—*Scaphites* sp. cfr. *S. aquisgranensis* Schüter; ventral and lateral views of UT–119; x1

FIGS. *5, 6*—*Stantonoceras sancarlosense* (Hyatt); ventral and lateral views of UT–30727; *5,* x0.55; *6,* x0.5

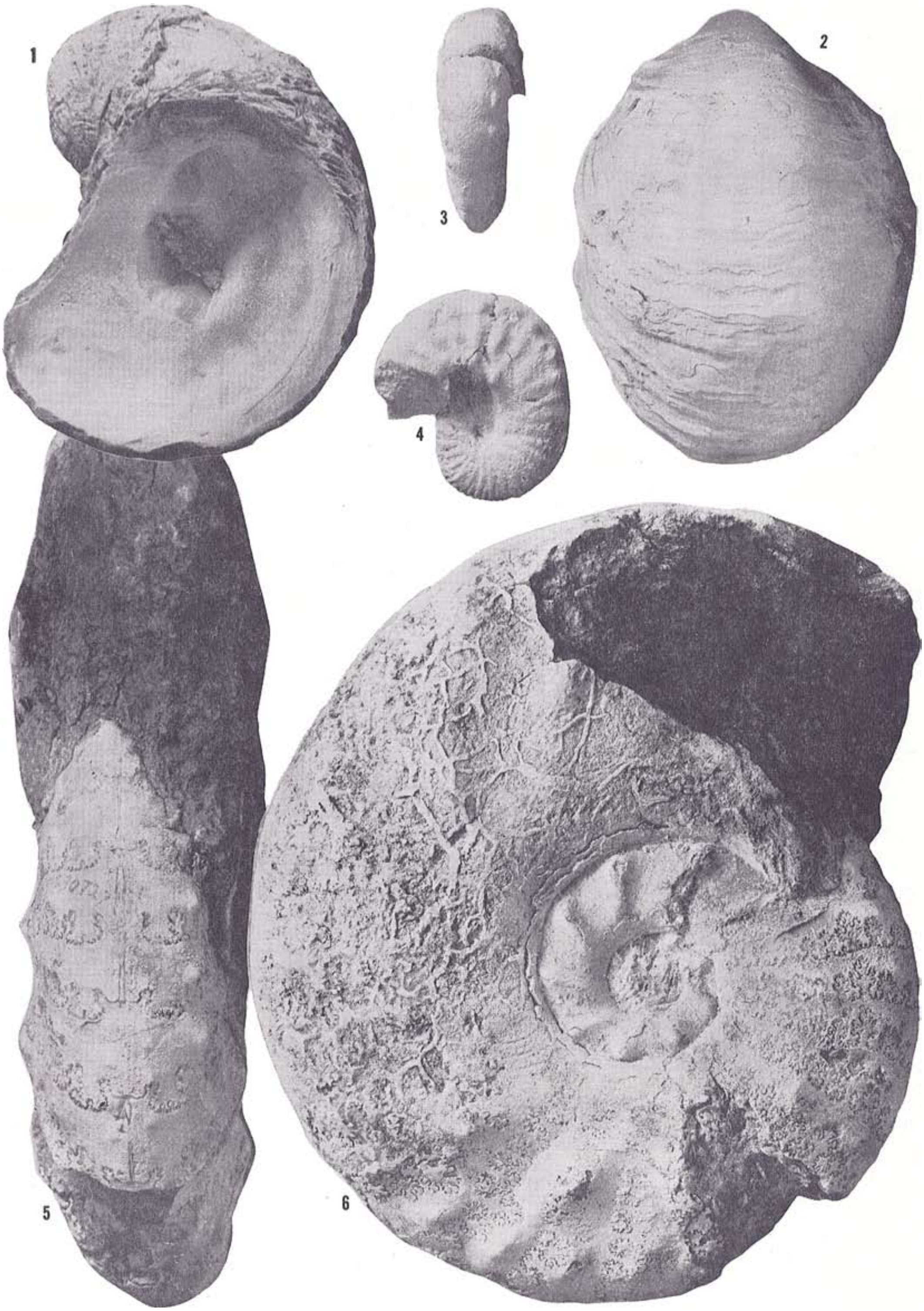

1
2
3
4
5
6

PLATE 81

FIGS. *1–3*—*Inoceramus undulatoplicatus* Römer; left valves; *1,* UT–30564; *2, 3,* UT–30691; *1, 2,* x0.5; *3,* x1

FIG. *4*—*Hoplitoplacenticeras marroti* (Coquand); lateral view of BEG–34774 (*see also* pl. 17, figs. 3, 4, and text fig. 11a); x1


1
2
3
4

PLATE 82

FIGS. *1–4*—*Inoceramus undulatoplicatus* Römer; two views of UT-30719; *1, 3,* x1; *2, 4,* x0.5


1
2
3
4

Index

Paleontology

Bold face numbers refer to pages on which specific descriptions appear